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THE WORCESTER-MILLBURY SEWAGE POLLUTION suit has resulted in a decision by the court that a nuisance exists in the Blackstone River, in Millbury; that the city must take steps to remove objectionable matter from the sewage before discharging it into the River; that the city report within three months what steps it has taken to abate the nuisance; and that the city pay the costs of the litigation. We understand that the city some months ago began exhaustive investigations looking towards important changes in its sewerage system, especially the separation of the storm water and sewage proper.

BIDS FOR GARBAGE DISPOSAL, and for a garbage disposal plant, at Milwaukee, will be received until Jan. 15, as stated in detail in our advertising columns. The garbage of the city is treated by the Merz process, described in detail in our issue of Nov. 1, 1894.

THE PROHIBITION OF WOOD PAVEMENTS in Milwaukee and the requiring of concrete foundations for all pavements, is effected by an ordinance signed by the Mayor a few days ago. The general features of the ordinance are in accordance with recommendations by Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., City Engineer.

COBBLESTONE PAVEMENTS IN BALTIMORE are prohibited for the future by an ordinance just introduced in the city council. The ordinance provides that where the cost of paving is met by abutting property owners, they may choose from sheet or block asphalt, vitrified brick, Belgian blocks, mosaic blocks, or such other improved material as may be approved by the mayor and city commissioner. In case property owners do not make a selection within the specified time, it will be made by the commissioner, subject to the approval of the mayor.

SUBMERGED GAS AND WATER MAINS have been laid beneath the Quinnipiac River at New Haven, Conn. The gas main is 16 ins. and the water main 24 ins. in diameter, both being about 700 ft. long. Pile foundations were used where the bottom is soft, and Falcon flexible joints were placed about 50 ft. apart. The greatest depth of water was 25 ft., at mean high tide. The mains were tested to 150 lbs. pressure from time to time during the work, and at 80 lbs. on completion. The final test showed the gas main to be absolutely tight, while the water main leaked very slightly. The work was carried out for the water and gas companies by Mr. Jos. G. Falcon, of Evanston, Ill., as contractor, and with Mr. A. B. Hill, M. Am. Soc. C. E., of New Haven, as consulting engineer. Mr. Chas. A. Ferry was in direct charge of the work as Mr. Hill's assistant.

THE ELEVATION OF TRACKS at Allegheny, Pa., is to be carried into effect, and it is said that work will be commenced in the spring. The Pennsylvania R. R. will pay the cost of the work, but the city will pay for any damages resulting to property-owners. Mr. F. J. Torrence is chairman of the council committee on grade crossings.

THE PARK AVE. VIADUCT and its four-track drawbridge over the Harlem River, will be put in use for train service by the New York Central R. R. in January. The present low-level tracks under the viaduct will be abandoned, and the open cut filled in to the street level. The viaduct and drawbridge have been very fully described and illustrated in our columns.

THE BOSTON TERMINAL CO., of Boston, Mass., has been authorized by the Railroad Commissioners to issue additional bonds to the extent of $2,000,000. The $6,000,000 of bonds authorized last July have all been taken, and, with necessities arising to $4,115,000 in excess of that amount, the terminal company is again asking for more. It is, however, buying land for the city of Boston for streets, as well as for its great station, and out of the $10,000,000 required for expenditure the terminal company expects from the city about $1,000,000. This gives the maximum cost of the new station and approaches, roughly estimated, at between $9,000,000 and $10,000,000.

ELECTRIC AND STEAM TRACTION over the same railway tracks is briefly discussed in the report of the Railroad Commissioners of Connecticut. It is said that the New York, New Haven & Hartford R. R., with its ownership of the Meriden electric and the Stamford street roads, is admirably situated to introduce this system of operation, and that when the power-house at Berlin is finished and the electric cars are running over the New Britain branch, and over the New England R. R., between Hartford and New Britain, further developments may be expected in this direction, and, should there be sufficient travel to warrant it, the street cars of Meriden may be run into Hartford and New Haven with like connections elsewhere.

AN UNDERGROUND CABLE RAILWAY, called the Glasgow District Subway, has recently been put in operation at Glasgow, Scotland. It is a continuous belt line, 6½ miles long, partly in two single-track brick tunnels 11 ft. wide and 9 ft 6 ins. high above rail level; and partly in two circular iron-lined tunnels 11 ft. diameter. The 15 stations are in brick archwork, 28 ft. span, with an island platform at each station. In each tunnel is a 1½-in. steel cable, running at 15 miles per hour and driven by a simple non-condensing engine with one cylinder 42 × 72 ins. Messrs. Alexander Simpson, W. S. Wilson and Robert Simpson were the engineers.

THE HARDIE COMPRESSED AIR LOCOMOTIVE for trial on the New York elevated railways has been completed at the works of the New York Locomotive Co., Rome, N. Y. According to report it resembles the present steam locomotives, except that it has no smokestack, and a two-wheel instead of a four-wheel truck. The four driving wheels are under the reservoir which takes the place of the boiler, and the cylinders are under the cab. A compressor plant is being established at Greenwich St.

FOUR-CENT STREET CAR FARES IN CHICAGO are made compulsory by a bill passed by the common council by a vote of 63 to 3. The bill must still be approved by the mayor. It provides that six tickets must be sold for 25 cts., 12 for 50 cts., and 25 for $1.

THE UNDERGROUND TROLLEY SYSTEM, which is employed in the street railways in Lenox and upper Lexington Avenues in New York city, was stopped by the heavy snow storm on Dec. 16. The cause of the stoppage and the plan proposed for preventing it in future, was thus explained by Mr. F. S. Pierson, Chief Engineer of the Metropolitan Traction Co.:

A sudden drop in the temperature caused a thin coating of ice to form on the underground rails that carry the electric current. The shoes that slide along these rails and carry the current through the motor slid over the ice until the cars stopped. The ice acting as an insulator shut off the current from the car entirely. It took us some time to find out what the trouble was, and then we spent several hours equipping a car with knife-like scrapers that would take this ice off. By the time we got this car in working order the slots had filled up with snow and slush to such an extent that the tracks were so covered with snow that it took many hours to get the roads open. The loss of electricity through the slush and snow was comparatively small. Pure snow is not a conductor, but an insulator. It is the slush that runs into the slots from the street that causes the "grounding" of the current, as we call it. Now that we know that ice may form on the underground rails, we will be prepared with plows to scrape it off.

During the time that the Lexington and Lenox Avenue lines have been running they have never been blocked until yesterday. It is because of the success of these lines that the traction company has decided to put the underground electric system on the Sixth and Fourth Avenue lines. The system will work better on the downtown lines, because the cars will be run so often that they will keep the conduit cleaner. With plants to supply plenty of extra power when it is wanted, and cars equipped to scrape away the ice and snow from the electric rails, the electric system is just as reliable as the cable.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a glancing collision on the Erie R. R., near Rutherford, N. J., Dec. 22. As an eastbound freight train was approaching a westbound passenger train one of the freight cars jumped the track and fouled the other track so that it was struck by the passenger train. The engine was upset and the engineman and fireman were killed, but none of the passengers were hurt. As far as the officers of the road have been able to ascertain, the freight car was thrown from the track in front of the passenger train on account of a brakebeam falling upon the track.—A derailment at Danville Junction, Me., on the Grand Trunk Ry., was caused Dec. 21 by a broken rail. The engine and three passenger cars went down a 30-ft bank and 12 persons were injured, but none very seriously.

THE POWERHOUSE of the Lookout Mountain & Lula Lake incline railway, at Chattanooga, Tenn., was destroyed by fire Dec. 12. The car at the top was released by the burning in two of the cable, and ran down the incline until it left the track at a curve.

A WIRE SUSPENSION BRIDGE over Fish Creek, Wheeling, W. Va., gave way under a crowd Dec. 21, throwing about 40 persons into the creek. Two persons were killed.—The White Rock Creek bridge, near Boulder, Colo., gave way under a traction engine and reaping machine Dec. 14.

A BOILER EXPLOSION at a mine near Mingo Church, Pa., Dec. 14, resulted in the death of the engineman. The boiler was being started up to pump out the mine.—One of the boilers of the Kent Woolen Co.'s mill at Centreville, R. I., exploded Dec. 19, killing four persons. The boiler is said to have been of the Allen return tubular type, and to have been inspected only a few weeks before the accident.

A BROKEN HOISTING CABLE at the Virginius mine, Ouray, Colo., caused the cage to drop 1,400 ft. The five men in the cage were killed.

A GRADE-CROSSING COLLISION between an electric car and a locomotive occurred Dec. 16 at Dighton, Mass., on the New York, New Haven & Hartford R. R. The car ran away on the hill aproaching the crossing and knocked the locomotive off the track. Nobody was hurt.

THE BURNING OF THE SCHENLEY PARK CASINO in Pittsburg on Dec. 16, which caused the total destruction of the building and a loss of $400,000, was due to a most unusual cause. The building contained an ammonia refrigerating plant. The cylinder of one of the ammonia pumps burst, and the ammonia gas escaping came in contact with the fire in the boilers, and at once set the building on fire.

LAND-SLIDES CAUSED BY IRRIGATION have occurred on the line of the Canadian Pacific Ry. in British Columbia, and Col. Robert B. Stanton, M. Am. Soc. C. E., and Mr. James D. Schuyler, M. Am. Soc. C. E., were lately appointed a board of experts to examine into the matter for the railway company The San Diego "Union" speaks as follows of their experience:

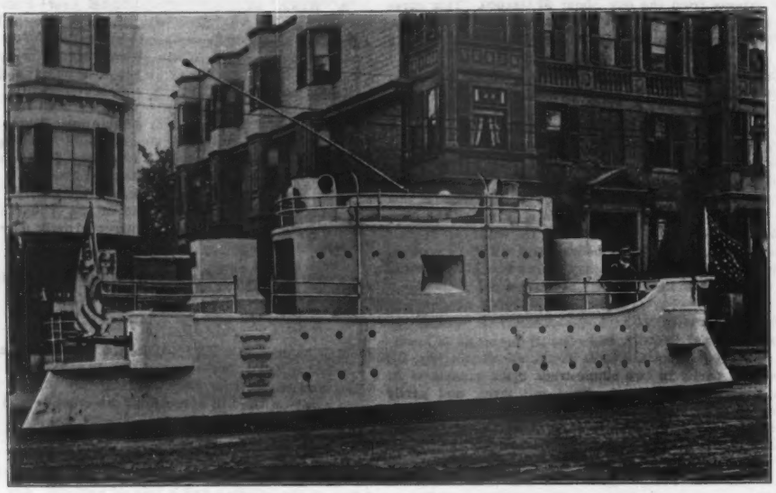
An action has been brought by the Canadian Pacific Ry. Co. to secure an injunction against the farmers on Thompson River to prevent them from further irrigating lands contiguous to the railways, this irrigation having already caused land-slides which have swept down upon the tracks of the company. Along this river the land rises in benches extending from 50 to 500 ft. above the river. The soil is gravelly, with a clay sub-soil. The farmers irrigate their lands by water from creeks back in the mountains, and the land is sliding downward apparently on the slippery clay sub-soil. In one place 66 acres have slid down in a mass, and the experts estimate the volume of one of these slides at 32,000,000 tons. At times the railway track has been shoved 5 ft. out of line in one night, causing great outlay in reconstruction. The jury has found in favor of the railway company, ascribing the slides to the irrigation.

THE CORROSION OF STEEL BOILERS by surface feed waters is being studied by the Steam Users' Association, and a circular has been issued to the members by Mr. Geo. Atkinson, Secy., 87 Milk St., Boston, asking for information concerning such corrosion and for samples of the feed water. An investigation of this corrosive action is about to be made by the Department of Water Analysis of the Massachusetts Institute of Technology, in charge of Mrs. Ellen H. Richards, to whom will be furnished samples of the water collected by the Steam Users' Association.

A SUBMARINE BOAT FOR WRECKING AND EXploring purposes is about to be built by the Columbian Iron Works, of Baltimore, after the plans of Mr. Simon Lake, a Baltimore inventor. The practicability of the design, it is stated, has been proved by experience upon a small boat. The boat will be capable of rising to the surface and submerging at will, and it may be propelled in any desired direction when on the bottom. A door may be opened, through which the occupants, by donning a diving suit, may pass from the interior to the outside and back again. The boat will be used principally for searching the bed of the ocean adjacent to coast lines and in locating and recovering sunken vessels and their cargoes. It will be about 54 tons displacement and will carry a crew of six men. It will be propelled while on the surface by an engine and screw of the ordinary type, and while under water the screw will be driven by an electric motor, taking current from storage batteries. A searchlight will light up the pathway of the vessel as she moves along the bottom.

## A WARSHIP ON A STREET RAILWAY.

The novel sight of a make-believe warship moving through the streets was a feature of many parades in Fitchburg, Mass., and neighboring towns during the recent election campaign. This singular craft is shown in the accompanying view, taken from a photograph sent us by Mr. W. W. Sargent, Superintendent of the Fitchburg & Leominster Street Ry. Co. The vessel was 37 ft. long, and was built on a construction car 26 ft. long,



A WARSHIP ON THE FITCHBURG & LEOMINSTER ELECTRIC RAILWAY.

with a wheel base of 6 ft. 6 ins., equipped with two 30-HP. Westinghouse motors. It was constructed of sheathing and timber, the whole being covered with canvas painted and varnished. The hull, turrets and boats were painted white; superstructure, yellow; iron work, bronze; guns, anchor and anchor chain, black. It was lighted with 25 incandescent lamps, and red fire was burned in the smokestack. It made all its trips without a breakdown or accident of any kind. At one time it carried 104 men, this being the entire crew of officers and men. The car was designed to run slowly through the street during a procession, with its crew marching in front, on both sides and in the rear, while many of the officers would ride; then during a long trip from town to town officers and men would ride together. It has now been dismantled and will be erected on a raft at the pleasure park of the railway company in the early spring. The boat was designed by Mr. W. W. Lapointe, naval architect, and was constructed at the car house of the railway company under the direct supervision of Mr. Sargent.

## MATHEMATICAL THEORY OF THE LIPPINCOTT PLANIMETER.

By Townsend Wolcott.

The accompanying engravings represent a new form of planimeter, which has been designed to obviate the defects which exist in other instruments of this class.

The wheel has a knife-edge, and is free to move on its shaft, so that there can be no slipping on the surface upon which it travels, giving the same results upon the roughest table as when used upon the finest paper.

In other instruments, in tracing some lines of the diagram, the wheel travels at right angles to its shaft, so that it can roll freely; at other points, the direction of its motion is changed until it is compelled to move in a line with its axis, so that the edge simply scrapes over the paper. For this reason the accuracy of these instruments is largely dependent on the texture of the surface upon which the wheel moves. This feature also causes a variable resistance, which makes it difficult to closely follow the lines. With the Lippincott planimeter the sliding is done entirely upon the shaft, and not on the paper, and as this shaft is made of glass, it is practically frictionless.

Inside of this glass shaft is placed the scale, which is printed upon specially prepared paper, so that the greatest contrast and legibility may be ensured. The ends of the shaft are then hermetically sealed under a partial vacuum, so that the scale can never become discolored, or affected by the atmosphere.

Three of these tubes are provided with the instrument, each containing two scales, so that the mean effective pressure can be read directly for the following springs: 8, 10, 12, 16, 20, 24, 30, 32, 40, 50, 60 and 80, or other graduations can be substituted. The legibility of these scales can be seen by referring to Fig. 2, which shows the scale and tube full size.

By pressing the small knob found on the top of the instrument, as in Fig. 3, a steel point, P, is protruded through the pivot screw, thus providing a convenient method of setting the instrument to the length of the diagram to be measured.

With this construction, no bending of the tracer point can affect the reading, which is not the case where separate points are provided on the top for setting to the card length. This improvement is of vital importance where absolute correctness is demanded.

To use the instrument, select a tube containing the scale corresponding to spring used in taking the card, and insert the same in the clamp, as in Fig. 1, after which the clamp screw C is to be tightened sufficiently to prevent the tube from being easily moved.

Loosen the set screw and adjust the points P and T to the exact length of card, holding the instrument as in Fig. 3. The set screw is then firmly tightened.

Having fastened the card upon the table by thumb tacks, place the instrument as shown in Fig. 1, but with the tracer-point T at the upper left hand corner of the diagram. The wheel may be readily set to zero by moving the point R to the right or left before finally pressing it into the surface.

In tracing the right-hand diagram of Fig. 1, the starting point should be made somewhere in the steam line, so that the wheel will not strike the clamp before it moves to the right.

If the diagram is very short, the points may be set twice the card length. By tracing the diagram twice, the reading will be the M. E. P.

If a reading is desired in square inches, use a 40 scale, and set the points 4 ins. apart, without regard to length of figure. The points may also be set 5 ins. apart, and a 50 scale used, or 6 ins., and a 60 scale. The latter is preferable, when the figure is large.

As the operation of this planimeter is so different from that of other instruments of its class, it is thought that an explanation of its theory may interest the readers of Engineering News.

The essential peculiarity of the Lippincott planimeter is, that the quantity directly measured is not the rotation of a wheel, as in most other planimeters, but the axial motion of the wheel upon its shaft. As the rotation of the wheel is not measured, its amount is immaterial; and consequently the wheel may have any convenient diameter, and if the diameter becomes reduced by wear, no harm is done. In order that the wheel may register accurately, it is only necessary that it should be able to revolve upon its own axis, and upon a vertical axis through its point of contact with the surface on which it rolls, without skidding or slipping sidewise.

Like other planimeters it measures areas, but by selecting the proper scale and properly adjusting the tracing arm, the reading of the scale will give the area in the required units multiplied or divided by any required constant. The instrument is intended chiefly for measuring indicator cards where the required quantity is not the area but the mean effective pressure, which is obtained by dividing the area by the length. This is the quantity that the instrument gives when the scale used in the instrument is the scale of the spring with which the card was taken, and the length of the tracing arm is the same as the length of the card.

In the diagram, Fig. 4, we will first suppose the polar arm P stationary. As the tracing arm T revolves about the center O, the short arm t describes an equal angle in the same time, and the axis of the scale tube does the same. The axis of the scale tube therefore remains at all times tangent to the circle c. As the point of tangency is advanced through an elementary distance $t\,d\,\theta$, ($\theta$ being the angular motion of the tracing point in circular measure), it is evident that the rest of the scale tube must be pulled through the same linear distance, and that it also swings through the same angle $d\,\theta$. The angular motion is allowed for by the rotation of the integrating wheel, and the linear motion by the scale tube sliding through the hub of the wheel. The scale therefore registers the elementary arc $t\,d\,\theta$, and t being constant, the integral $\int t\,d\,\theta = t\,\theta$. The point of contact of the integrating wheel therefore moves in an involute to the circle c.

The sliding of the wheel upon the scale, due to the angular motion of T, is not affected by a simultaneous motion of P, for it is simply proportional to the angular motion of T in all positions of P. In carrying the tracing point around a closed figure, and back to the starting point it is evident that the arm T makes equal excursions in both directions. Therefore whatever the shape of the figure, for every positive element $t\,d\,\theta$, there is at some other part of the perimeter a corresponding negative element, $-t\,d\,\theta$,

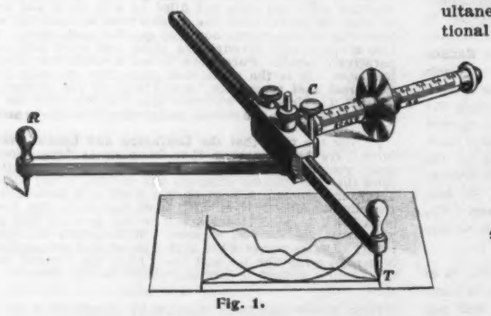



Fig. 1.

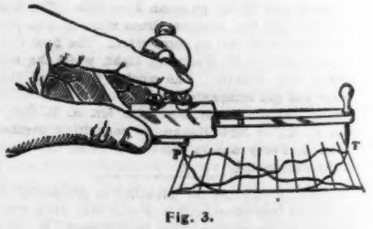



Fig. 3.

and t being a constant these two elements cancel and the integral $\int t\ d\ \theta$ taken clear around any closed path equals zero. As in practical use, the tracing point is always moved clear around a closed path, this motion of T or t does not in any way affect the final scale reading.

The only other motion in the instrument is the angular motion of the polar arm P. Suppose for the moment that these arms t and P are fixed at the angle $\psi$. The scale tube axis produced, is tangent to the circle e, and by a chain of reasoning similar to that before employed, it may be shown that the angular motion $d\ \varphi$ of the arm P causes an axial motion of the integrating wheel through a distance equal to the corresponding arc of the circle e. This is true also for the instantaneous motion $d\ \varphi$ when $\psi$ is variable. In any given figure, $\psi$ is a function of $\varphi$. The triangles O f h and R g h, are similar, and right-angled; therefore $\frac{t}{\cos \psi} = \overline{O\ h}$, and $\overline{O\ h} : h\ \overline{R} :: t : g\ \overline{R}$. That is $\frac{t}{\cos \psi} : P - \frac{t}{\cos \psi} :: t : g\ R$, or $P \cos \psi - t = \overline{g\ R}$, and the axial motion of the integrating wheel is $\int (P \cos \psi - t)\ d\ \varphi$. The integral $-\int t\ d\ \varphi$ disappears for a closed path, just as does the integral $\int t\ d\ \theta$, so that all that remains is the integral $\int P \cos \psi\ d\ \varphi$.

This does not in general disappear for a closed path, for $\psi$ being variable the corresponding elements $P \cos \psi\ d\ \varphi$ and $-P \cos \psi\ d\ \varphi$ are not necessarily numerically equal, and do not necessarily cancel.

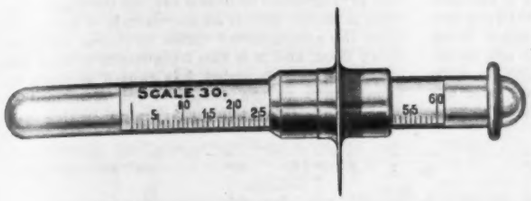



Fig. 2.

To show that the integral $\int P \cos \psi\ d\ \varphi$, is proportional to the area actually described by the tracing point, we will first take the area a, b, c, d, e, in Fig. 5. In this figure $\overline{R\ g} = P$, $g\ a = T$, and g is a right angle. That is $\psi = \frac{\pi}{2}$ and $\cos \psi = 0$, and therefore $\int P \cos \psi\ d\ \varphi = 0$, from d to a. From a to b, $\varphi$ is constant, and also from c to d, leaving only the arc from b to c, where the integral is finite. Now for this portion of the path $\psi$ being constant $\int P \cos \psi\ d\ \varphi = P \cos \psi . \varphi$. As the figure c, d, e equals the figure b, a, f, the figure a, b, c, d, e equals the figure b, c, e, a, f. The area of this by the rule for circular sectors, is

$$\frac{\overline{R, b}^2 - \overline{R, a}^2}{2} \varphi.$$

The radius $\overline{R, b}$ is the third and longest side of a triangle, the other (given) sides being P and T, and the included angle the supplement of $\psi$. In Fig. 6, erect the perpendicular p, q; this is evidently equal to T sin $\psi$, and O, p = T cos $\psi$. Then $\overline{R, b}^2 = (P + T \cos \psi)^2 + (T \sin \psi)^2 = P^2 + 2\ P\ T \cos \psi + T^2 (\cos \psi)^2 + T^2 (\sin \psi)^2 = P^2 + T^2 + 2\ P\ T \cos \psi$. The square of the radius $\overline{R, a}^2 = P^2 + T^2$, therefore,

$$\frac{\overline{R, b}^2 - \overline{R, a}^2}{2} \varphi = P\ T \cos \psi . \varphi$$

which differs from the scale reading only by the constant coefficient T.

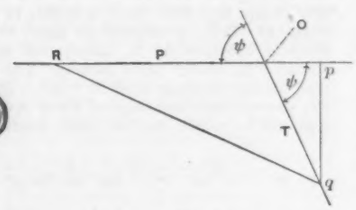



Fig. 6.

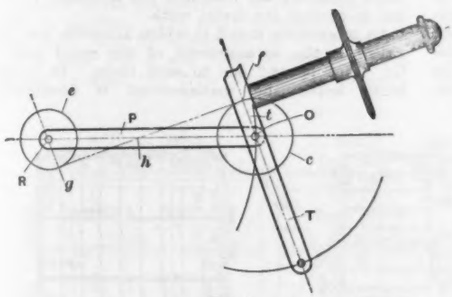



Fig. 4.

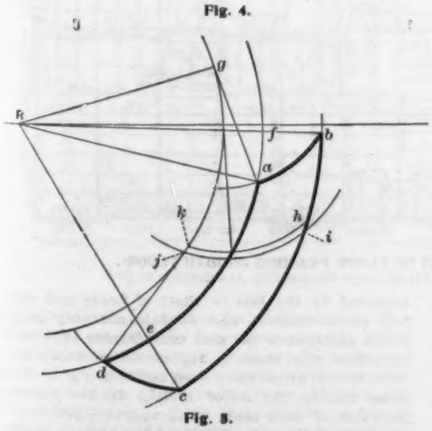



Fig. 5.

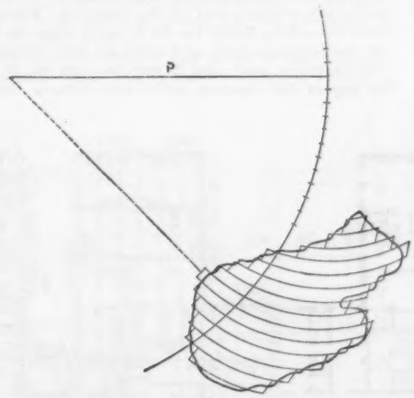



Fig. 7.

For any radius smaller than $\overline{R\ .\ a} = \sqrt{P^2 + T^2}$, $\psi$ is obtuse and therefore cos $\psi$ is negative. But if the tracing motion be reversed $\varphi$ becomes negative, and cos $\psi . \varphi$ positive. This is what it should be, for if the tracing point move from b to c to register positively, giving the correct area (or known fraction thereof) it must move in the opposite direction to add an area lying within the zero circle d, e, a, f, otherwise the combined area could not be evaluated by a single continuous motion of the tracing point around the figure.

Having shown that the planimeter correctly evaluates a figure of the form of Fig. 6, it remains to show that it will do the same for any other figure. In the elementary area h, i, j, k, Fig. 5, the ends $\overline{h\ .\ i}$ and $\overline{j\ .\ k}$ are the only parts that contribute anything to the scale movement, $P \cos \psi\ d\ \varphi$., Therefore, if any number of these elements be placed side by side, their combined perimeter will be less than the sums of their separate perimeters by twice the length of the coalescing sides, yet as these coalescing sides take nothing from the scale reading the combined area is correctly evaluated. By taking these elementary areas of different lengths a finite area of any form may be built up, as in Fig. 7, and its area will evidently be correctly evaluated by following its perimeter with the tracing point.

In an indicator card, the area of the diagram divided by its length gives the mean ordinate. Therefore, if in this planimeter the length of the arm T be made equal to the length of the diagram, the scale reading will give the mean ordinate, for the scale reading is $\int P \cos \psi\ d\ \varphi$, and the area $\int T\ P \cos \psi\ d\ \varphi$. If this movement is measured with the scale of the spring with which the card was taken, the scale reading is the mean effective pressure.

The Lippincott planimeter is sold by the Hine & Robertson Co., 68 Cortlandt St., New York city. Its price is $15.

## WATER DEVELOPMENT BY TUNNELING AT ONTARIO CAL.

By Jas. T. Taylor, M. Am. Soc. C. E.

The Ontario Tunnel, commonly known as the Bodenhammer Tunnel, is located on Mountain Ave., about one mile west of the famous Euclid Ave. of the Ontario Colony lands, San Bernardino Co., Cal., and about 5½ miles northwesterly from the growing and prosperous city of Ontario.

The mouth of the tunnel is very near the San Bernardino base line, at an elevation of some 1,700 ft. above sea level, and commanding a large area of land which has been demonstrated to be first class for the successful growth of citrus fruits.

Mountain Ave. runs north and south and at right angles to the general slope of the upper portion of the valley, or mesa, and has an average fall of about 200 ft. per mile.

The object of the tunnel was to intercept the underflow from the mountain range known as the Sierra Madre, and divert the waters so developed by gravity into the present system for an increased supply of the Ontario lands, and possibly other lands in the immediate vicinity.

Prior to the commencement of the tunnel proper several shafts were sunk to a considerable depth and tests of the water supply made by pumping. These tests, as reported, seemed to indicate a considerable volume of water available, and to support in a measure the theory advanced by the promoters, and concurred in by the "water witch enthusiasts," that a stream af water exceeding 1,000 ins. was running to waste, and only required tapping to secure and control the precious fluid.

The glowing accounts and reports of the hidden treasures, coupled with the growing necessity for a more ample supply of water for the Ontario lands, led to the making of the contract by the San Antonio Water Co., on the part of the property owners, with Mr. Bodenhammer, et al., the promoters, for the development and delivery of a water supply, on a basis of $500 per in., measured at the mouth of the tunnel, the company to furnish the capital for the development under the management of the promoters.

The tunnel is timbered throughout with 6×6-in. redwood, and 2×6-in. redwood for lugging. The bottom width is 4 ft. in the clear, the top width 3½ ft., and the height is 6 ft. The bottom of the tunnel and the sides to a height of 1 ft. are lined with concrete. The total length of tunnel is about a mile, and there is about one-fourth mile more of shafts along the line of the tunnel.

Nothing of particular interest occurred in the cutting of the tunnel until the water stratum was entered at the face of the tunnel, causing a cave. After abandoning further development in the main tunnel, considerable water flowed into the tunnel for a time, until, about Jan. 1, 1896, it reached its normal flow, discharging at the mouth of the tunnel 4 miners' ins.

At this time the promoters of the enterprise decided to connect the tunnel with a shaft about 210 ft. deep, at a point about 20 ft. back from the face, and run side drifts or tunnels into the water-bearing stratum above the main tunnel, first by pipes and afterwards by shaft. Some four wells were

driven before a connection was made to be of any benefit in increasing the supply of water in the tunnel below. The first well was started with pipe 14 ins. in diameter, and reducing to 12, 10, 8 and 6 ins. The second well was bored to a depth of 165 ft., where some tools were lost and this well abandoned. Well No. 3 met with the same fate at about 175 ft., and well No. 4 was finally driven to the tunnel and a connection made. On cutting the pipe at the water stratum, some considerable water was obtained for a time, diminishing, however, until the normal flow was reached, which resulted in about 30 miners' ins. The pipe also filled with debris, and it was found necessary to excavate the shaft the full depth to allow the water to enter the tunnel.

The sinking of the shaft was a very tedious and expensive operation, as the several pipes had to be cut out in pieces as the work progressed.

The expense of the work, including tunnel, shafts and accessories, has exceeded $75,000, and the additional tunnel must be necessarily expensive.

In consequence of the existing conditions, and the enormous outlay and resultant limited supply of water, sealed proposals were called for, to be received on Monday, Sept. 13, at Ontario, Cal., by the San Antonio Water Co., for the construction of certain proposed extensions of the tunnel, resulting in the awarding of a small contract to a local contractor. Work is still progressing on the tunnel, with some success in increasing the water supply.

This tunnel is one of the sources of water supply of the Model Colony, of Ontario. The total supply for the present season is now approximately as follows:

| | Miners' ins. |
|---|---|
| San Antonio Creek | 165 |
| San Antonio Tunnel | 81 |
| Frankish & Staur Tunnel | 18 |
| Bodenhammer Tunnel | 25 |
| Total | 289 |

The direct effect of the light rainfall for the winter of 1895 is shown by the unusually small surface flow of the San Antonio Creek.

## THE STRUCTURAL FRAMEWORK OF THE ASTOR HOTEL, NEW YORK CITY.

(With inset.)

We illustrate this week the principal details of the structural work of the new Astor Hotel, now being erected at Fifth Ave. and 34th St., New York city, for Mr. John Jacob Astor. Mr. H. J. Hardenbergh is the architect, and the steel structural skeleton has been designed by and built under the supervision of Messrs. Purdy & Henderson, of New York city. Mr. John Downey is the general contractor, and the steel work has been built and erected by J. B. & J. M. Cornell, of New York. We are indebted to Messrs. Purdy & Henderson and to Mr. Hardenbergh, for the material used in the preparation of this article.

The Astor Hotel adjoins the famous Waldorf Hotel, on the northwest corner of Fifth Ave. and 33d St. The architectural design of the new building has been made to harmonize with that of the older one. The main dining-room in the new building will connect directly with that of the Waldorf, making practically one room extending across the entire length of the Fifth Ave. front of the ground floor of the two buildings. This room, 50 × 200 ft., will be practically unobstructed by columns, having only a row of columns along each side, about 6 ft. from the wall. The great ballroom, 85 × 96 ft., on the first floor, will also be free from columns, so that special truss designs have had to be introduced to carry the columns of the upper floors. On the 34th St. side of the first floor there will also be a banquet room, 40 × 72 ft., occupying the space between two rows of columns, 40 ft. apart, this space being spanned by heavy plate girders. The site occupied by the building is 98 ft. 9 ins. × 335 ft., with the shorter side fronting on Fifth Ave., and the rear will be broken by four light courts. The 34th St. front will be opened so that at the main entrance carriages can be driven across the sidewalk directly into the building. The steel columns on the front of the building are covered with cement grouting, brickwork, and a sandstone finish. The exterior of the building is of red brick, with red sandstone trimmings.

The foundations are all on solid rock, 35 ft. below the street level, or deeper where required. The rock surface was found about 3 ft. below the level of the street, at the Fifth Ave. end, and then at increasing depths to a maximum of 65 ft. under the western end of the building. Foundations extending below the 35 ft. level were opened for the required area, and built up with concrete. The carrying load was 29,000 lbs. per sq. ft. at the top of the concrete piers thus formed. Upon the rock or the concrete piers (as the case may be) are brick piers, with granite caps for the column shoes.

Fig. 1 is a diagram plan showing the arrangement of the columns, but its more important purpose is to show the position of the several trusses, to which reference will be made later. The three trusses, D, E, F, on the east side of the building are to support the columns above the first floor, leaving the ground floor clear for the great dining-room, which occupies the space between columns 1, 16, 17 and 21. The trusses at the west end of the building are to carry the columns above the fourth floor, leaving that part of the fourth floor clear of columns for the great ballroom, which will be 85 × 96 ft., occupying the space between columns 162, 167, 219 and 226.

Fig. 2 shows a part of the floor framing of the eighth floor, and is a typical example of the framing system adopted, which is composed of I-beams and plate girders, there being some 1,600 tons of the latter in the building.

Fig. 3 is a portion of one of the architect's plans of the interior arrangement, and represents the general arrangement of rooms, etc., on the eighth floor. This is shown merely as an example of the design, since the arrangement varies, of course, on nearly every floor, and it is this irregularity in floor plan which, as already noted, has caused so much unusual study in the design of the structural arrangement, this structural design having been subordinated to the architectural design regardless of expense.

This eighth floor is one of the floors devoted entirely to living rooms, and it will be noted that the suites of rooms on the Fifth Ave. front have a private hallway inside of the main public corridor. All the rooms have either gas-log hearths or open fireplaces, and the number of flues required by the latter proved to be one of the disturbing elements in the structural design, it being necessary to arrange the framing and connections so as to leave room for the flues and the necessary clothing to protect the metal work.

An interesting detail to which attention may be called is the arrangement of the small spaces for "shoe boxes," one to each room. In every large hotel, the management is constantly troubled by the loss or theft of boots and shoes left to be cleaned, and as this not only causes much annoyance but also considerable expense in providing new shoes to replace those which have been stolen, steps have been taken to put a check upon this in the Astor Hotel. In the corridor partition of each room is an aperture just above the floor, and on the inside of the room is a shoe box, having a glass door flush with the partition and another door opening into the room. The occupant of the room puts his shoes in the box at night and latches the door. The porter making

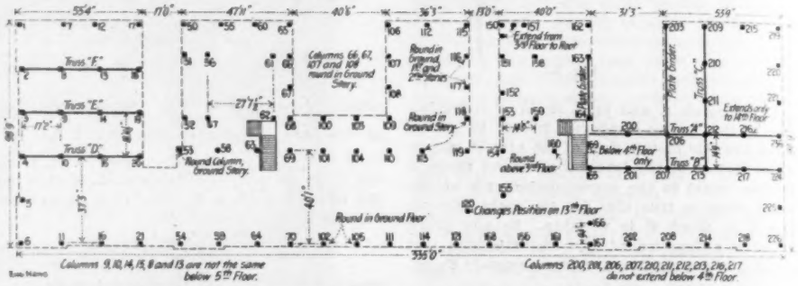

Truss "F"
Truss "E"
Truss "D"
Round Column, Ground Story.
Round in Ground Floor
Changes Position on 13th Floor
Below 4th Floor only
Extend from 3rd Floor to Roof
Plate Girder
Truss "A"
Truss "B"
Extend only to 4th Floor
335'0"
Columns 9, 10, 14, 15, 8 and 13 are not the same below 5th Floor.
Columns 200, 201, 206, 207, 210, 211, 212, 213, 216, 217 do not extend below 4th Floor.

FIG. 1.—PLAN SHOWING COLUMNS AND TRUSSES IN THE ASTOR HOTEL, NEW YORK CITY.

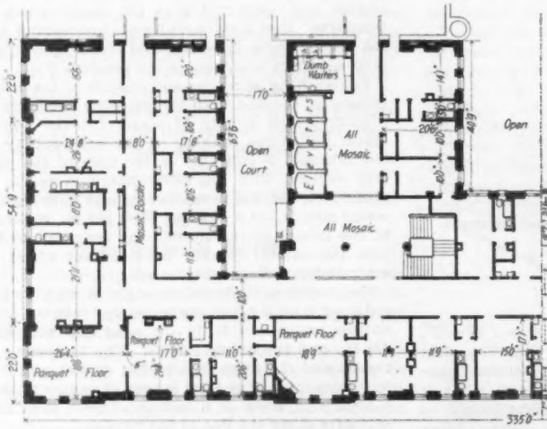



FIG. 3.—PART PLAN OF INTERIOR ARRANGEMENT (EIGHTH FLOOR).

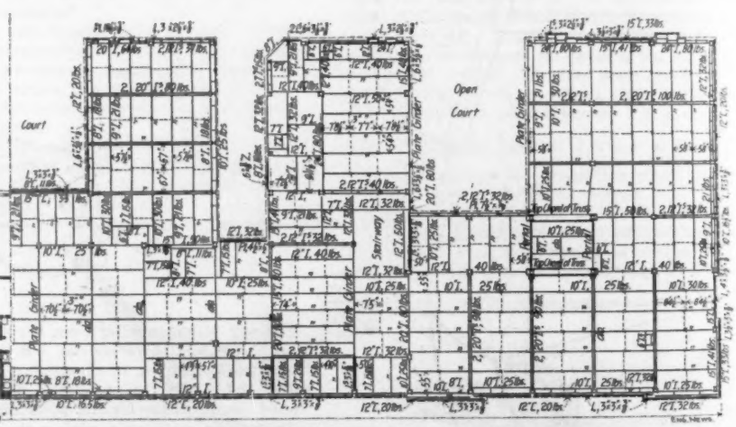



FIG. 2.—PART PLAN OF FLOOR FRAMING (EIGHTH FLOOR).

his rounds can see through the glass door whether there are any shoes; if so, he unlocks this door and takes the shoes out. When they have been cleaned they are put back and the door again locked.

Fig. 4 shows the lower section of column 280 (supporting the trusses), which is the heaviest column of the entire building, and carries the greatest load, namely, 5,400,000 lbs. This enormous column has 10 web plates, 4 cover plates and 12 angle irons. Its length is 30 ft. 4 ins. and its weight is 46,980 lbs. A view of the column is given in Fig. 5. Some of the standard column sections are shown in Fig. 6, and these need little explanation. In some cases a column of small size but with a great mass of metal became desirable, the dimensions being limited by reason of the enclosing of the column in a circular shell of polished stone, and for this particular purpose the column sections shown in Fig. 7 were devised by the engineers, the form comprising a heavy concentration of metal in a section well adapted to re-

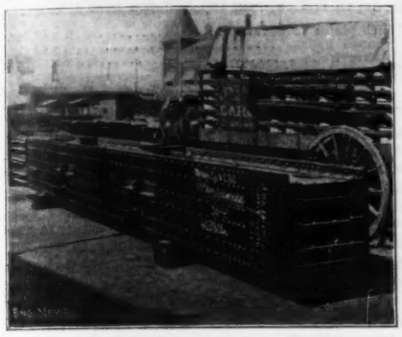


Fig. 5.—View of Large Column, No. 280.

ceive a circular clothing, as shown. Fig. 8 also shows a column of this type, with the variations in its construction for the several floors which it carries.

The construction as thus far described does not present any exceptional features of design, except in matters of dimensions and details, but we come now to the consideration of the solution of a difficult problem. The great ballroom is on the first floor, with its ceiling at the level of the fourth floor, and it was required that this room should be kept free from obstructing columns. Had this been an upper floor, the design of a truss roof would have been easy enough, but it must be remembered that there are 16 floors, and that the ballroom trusses must carry the supporting columns of the floors above. It must also be remembered that the trusses had to be designed so as not to interfere materially with the arrangement of the rooms above the fourth floor or to diminish the value of the space for hotel purposes. These considerations greatly complicated the actual design of the trusses.

Fig. 9 shows the solution of this problem, which was eventually adopted. Each of the two trusses is triangular in form, 51 ft. 3 ins. deep, its lower chord being built into the fourth floor and its upper chord built into the eighth floor. The top chord is 17 ft. and the bottom chord 84 ft. 9 ins. long, c. to c. of pins. The lower chord is of unusually large eyebars, 12 ins. deep, with 12-in. pins. The truss is of the double-deck type, having a horizontal member at mid-height (sixth floor) while the two intermediate floors (fifth and seventh floors) are carried mainly by brackets on the truss posts and columns. The middle panels have diagonal bracing, as shown. It was at first planned to have the two upper diagonal pieces of the upper panel and the two lower diagonal pieces of the lower panel formed by square rods 3 × 3 ins. with welded loop ends. In the manufacture of these rods, however, it was found to be difficult to obtain satisfactory and reliable welded joints in bars of this size, and eyebars 6 × 1½ ins. were therefore substituted, these bars having upset threaded ends and turnbuckle connections, as shown, and as originally planned for the square bars.

The use of trusses under such conditions is, of course, not new. They were employed as long ago as 1887, by Wilson Bros. & Co., of Philadelphia, in the Drexel Building, where two trusses were used, as shown in our issue of March 19, 1890. These had clear spans of 48 ft. 10½ ins. and 58 ft. 3½ ins., and each extended through four floors, one being from the fourth to the eighth floor, and the other from the fifth to the ninth floor. One of these carried eight and the other seven floors, including that of the bottom chord.

Again, in the construction of the extension of the Waldorf Hotel in New York city, it was required to leave a ballroom on one floor unobstructed by columns, and for this purpose a truss arrangement was designed by Mr. Purdy, the consulting engineer for the ironwork. This truss, which was fully described and illustrated in our issue of March 5, 1896, is 82 ft. 6 ins. long and 28 ft. 4 ins. deep, its bottom chord being at the second floor level and its top chord at the fourth floor level, while the first floor is carried by columns which extend below the truss and act now as suspenders. When the new Astor Hotel is completed the ballroom in the Waldorf extension will be given up, and columns will then be put in between the ground and first floors, as was described in our former article.

The detailed construction of one of the two great ballroom trusses in the Astor Hotel is shown in

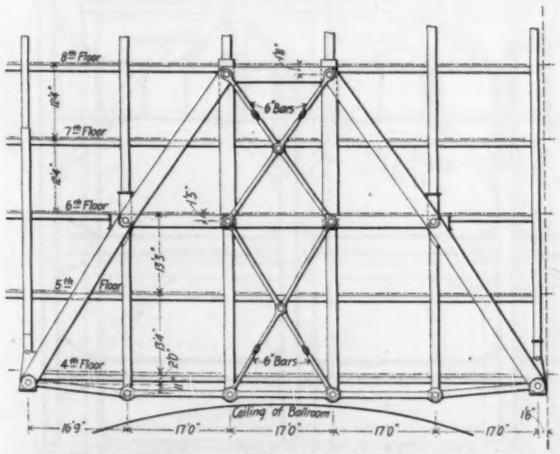



FIG. 9.—GENERAL DESIGN OF BALLROOM TRUSSES.

Fig. 10. The lower chord is composed of four parallel sets of eyebars 12 × 2 1-16 ins., with 10-in. pins except at the endpost shoes, where 12-in. pins are used. These shoes are steel castings with ribbed top surfaces to fit the webs of the posts. In the lower half of the truss the end posts have an immense amount of metal, there being no less than 10 web plates (in five pairs), ⅞ × 29½ ins., two cover plates ½ × 36 ins., and 12 angle irons ½ × 4 × 6 ins. The cross-section of the member, on Fig. 10, gives an idea of the great amount of metal used. At the base of the end post is a column connecting with the column seated on a 6-in. pin, as shown on the right of Fig. 10, and also in Fig. 11. In the upper half of the truss each end post consists of 6 web plates ⅞ × 29½ ins.; 2 cover plates, ½ × 38 ins.; 4 angle irons, ⅞ × 4 × 6 ins.,

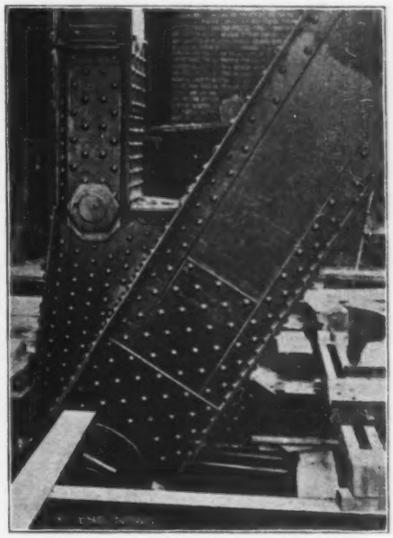


Fig. 11.—View of Base of End Post of Ballroom Truss.

and 4 angle irons, ½ × 4 × 6 ins. The top chord is composed as follows:

| | |
|---|---|
| 1 Web plate | ⅞ × 29½ ins. |
| 2 Web plates | ⅞ × 29½ ins. |
| 2 Cover plates | ½ × 41 ins. |
| 8 Angle irons | ½ × 4 × 6 ins. |

The middle chord, at the sixth floor level has two channel-shaped sides, each composed of a web plate 7-16 × 23½ ins., and two angle irons ½ × 3½ × 4 ins., these sides being connected by horizontal lattice bars ⅝ × 4½ ins. The chord connects with each end post by a 12-in. pin, which also forms the seat for a column rising above it.

The two trusses, A and B, are practically alike. They are spaced 14 ft. 9 ins. apart, c. to c., and the middle posts are connected on each floor by arched portal bracing, as shown in Figs.

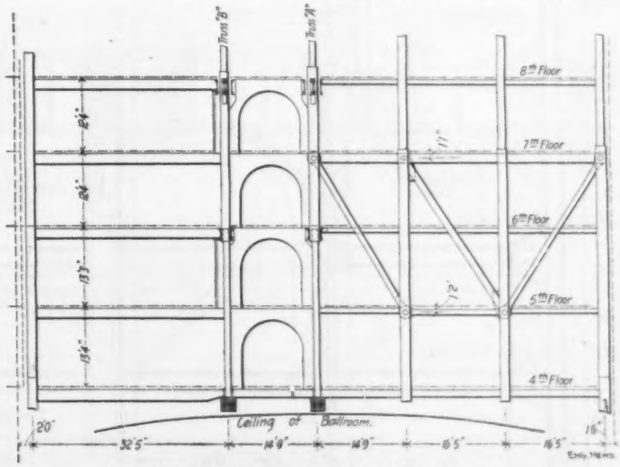



FIG. 12.—ELEVATION SHOWING POSITION OF TRUSS C.

10 and 12. Two general views of these trusses are shown in Figs. 13 and 14. These trusses were built by the Keystone Bridge Co., of Pittsburg.

It will be seen on reference to Fig. 1 that truss A carries one end of another truss which is at right angles to A and B, this being marked truss C. This carries the weight of the floors over the end of the ballroom. One end of the truss is carried by a 10-in. pin in the post of truss A, while the other is carried by a 10-in. pin in the wall or abutment column No. 209. The truss connection

makes a somewhat complicated arrangement necessary, since it causes a double reversal of the strains in the post, the bearing on the 10 in. pin of truss C being at right angles to the top and bottom pins of truss A. The details of this truss are shown in Fig. 15.

Similar conditions exist at the dining-room on the ground floor of the Fifth Ave. front. Here it was stipulated that the position of the side columns should conform to that of the columns in the dining-room of the Waldorf Hotel, so that when the party wall is opened there will be one large room practically unobstructed by columns, as already noted. In order to meet these requirements and to carry the columns of the 14 floors above the dining-room it was necessary to devise a truss arrangement, and this is shown in Fig. 16, which is truss D, one of the three which span the dining-room. The posts of this truss are practically inclined columns connecting the vertical columns above and below, the truss being two stories in depth. In consequence of the arrangement of the corridors and rooms, no diagonals could be placed in the center panel of the truss, and the somewhat singular arrangement of counters in the end panels had therefore to be introduced. It was at first proposed to make these counters or diagonals of 3-in. square rods with welded loop ends, but for reasons already stated eyebars $1\frac{1}{2} \times 6$ ins. were substituted, having the ends upset and threaded for the turnbuckle connections. The posts are of box section, having 6 web plates, 2 cover plates, and 8 angle irons. The chords are each composed of 2 plate girders 28 ins. deep, $20\frac{1}{2}$ ins. apart, having the flanges connected by lattice bars. The truss is 26 ft. 8 ins. deep, c. to c. of pins, and its length is 51 ft. 7 ins. At the bottom, the center panel is 35 ft. 10 ins., while one side panel is 7 ft. 7 ins., and the other 8 ft. 2 ins. At the top, the center panel is 17 ft. 3 ins., and the two side panels are 17 ft. 2 ins., all c. to c. of pins. Brackets on the columns and truss posts carry the beams of the fourth floor, which crosses the truss at its mid-height.

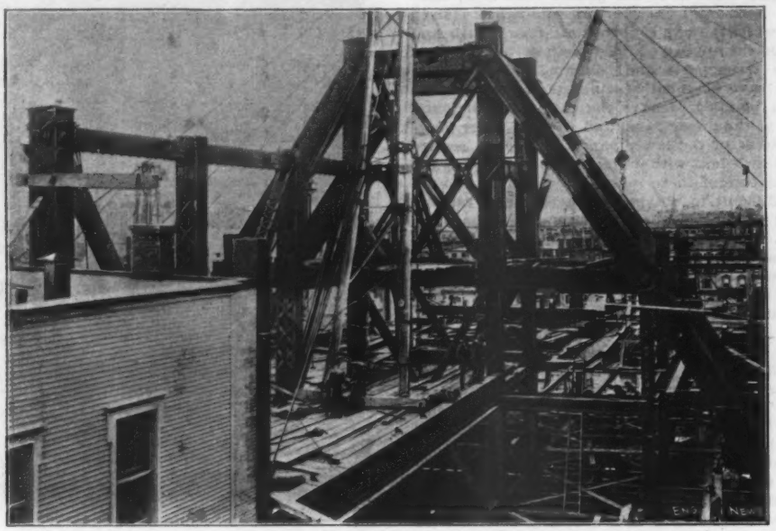


FIG. 13.—VIEW OF STRUCTURAL WORK, SHOWING THE BALLROOM TRUSSES, A, B AND C.

Another interesting feature in the structural design is the method of supporting the great ballroom trusses A and B, for, as will be seen on reference to Fig. 1, they are not seated upon columns. The spacing of the columns in the western end of the building is entirely changed at the fourth floor level, and to provide for this a line of heavy plate girders was introduced, and the trusses rest on one of these girders instead of directly upon the columns. It should be explained that this complicated arrangement was necessitated by requirements of the owner of the building in order to facilitate the use of the lower stories, and to satisfy architectural ends.

This peculiar arrangement is shown in Fig. 17, the lower part of which shows in dotted lines the finished outline of the architectural work in the spaces between the columns, and shows also the knee-braces or stiffeners connecting the columns and girders. The trusses and columns above are not in line with the columns below, but eccentrically on either side of column 280, which is the heaviest column in the building, as already described. The continuous plate girder resting on columns 279, 280 and 281, is of very massive construction; the total length is only 35 ft. 6 ins., but the depth is 7 ft., and the makeup is as follows:

6 Web plates ..... $\frac{3}{4} \times 81$ ins.
4 Flange plates..... $\frac{5}{8} \times 42$ ins.
12 Angle irons ..... $\frac{5}{8} \times 6 \times 8$ ins.
Filler plates continuous throughout.

As the steel skeleton up to the second floor forms practically the foundation for the trusses and the superstructure which they carry, it is essential that this lower part of the work should be absolutely stiff and rigid, for which purpose a very complete system of knee-bracing and gusset-plate connection has been introduced, as shown diagrammatically in Fig. 18, which represents the portion immediately below that shown in Fig. 17. The steel foundation work is also tied together rigidly by horizontal diagonal bracing of flat bars riveted to the top of the floor beams for the floor which forms the ballroom ceiling, and in some of the upper floors.

The wind bracing is of a very substantial character, consisting of heavy diagonal bracing of channel irons, with vertical bars from the intersection of the diagonals to the floor beams below. An example of this is given in Fig. 19, showing the bracing between columns No. 163 and No. 164, extending from the sub-basement level (or the feet of the columns) to the fourth floor.

All the main structural work is of mild steel, and members are given one coat of paint at the shops and two coats after erection. A graphite paint is used, supplied by the Detroit Graphite Mfg. Co., containing 33% of graphite and 20% of iron oxide. The columns are enclosed with brick ma-

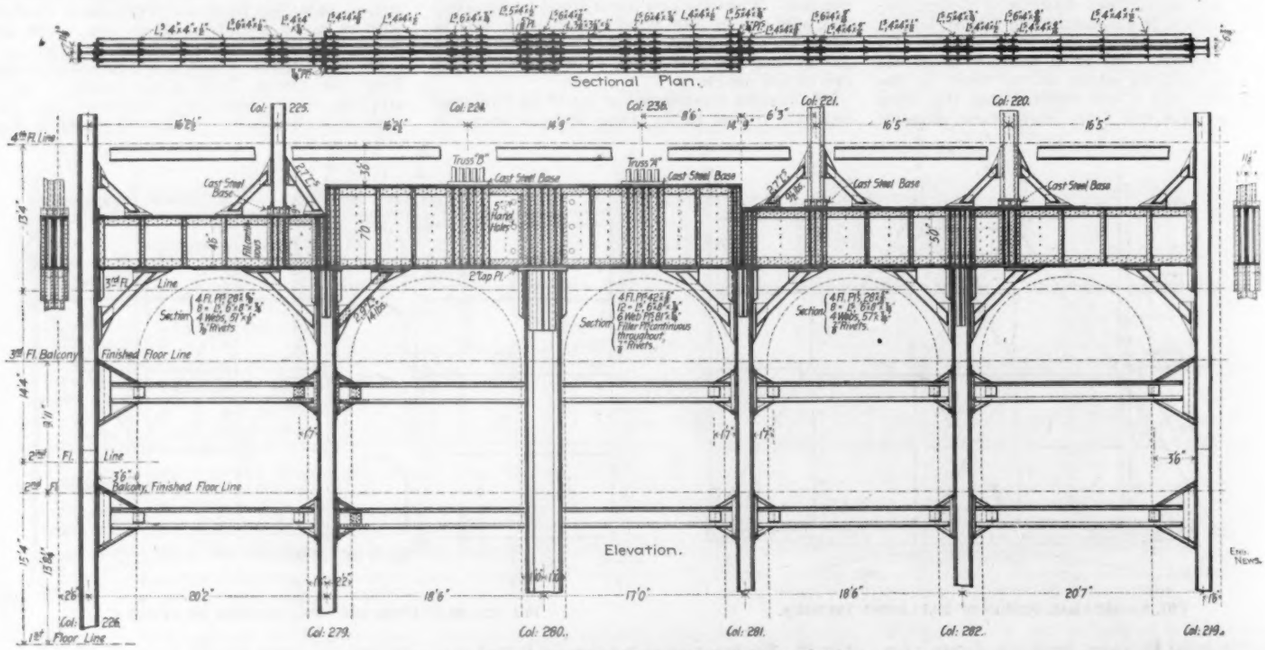



FIG. 17. GIRDER SUPPORTS FOR THE BALLROOM TRUSSES.

sonry in cement, laid close in contact with the metal work.

The building will contain about 10,000 tons of structural steel work, the cost of which represents about one-tenth of the total cost of the building. This proportion is said to be unusually low, particularly when the great spans between the columns (and the consequent heavy construction) are taken into consideration.

THE REPORTED FAILURE OF THE STEEL PLATES intended for use in the hulls of the battle ships now under construction at Newport News is causing a good deal of newspaper comment, but the whole facts in the case will not be known until the report of the investigating board is made public. The "American Manufacturer" of Dec. 18 has an editorial on the subject, probably based on statements it has received from the manufacturers of the plates. It says:

Sufficient is known to show that the fault did not lie with the makers of the plate. It seems that there was an error, and that error was such as could easily be made by any one not thoroughly posted on the manufacture of steel. Among engineers nowadays it is the rule to require great tensile strength in steel material. Years ago 50,000 lbs. tensile strain was considered a very satisfactory test, and steel of that composition could be bent and twisted in any way. But now specifications will call for a tensile strength of 70,000 lbs., forgetful of the fact that to get this, more carbon must be added, and that tensile strength is secured at the expense of ductility. This was exactly the case in the plates about which so much has been published. Each and every one of those plates were made according to specifications, and all stood the government test.

This statement does not harmonize with statements made in a press despatch from Norfolk published in the New York "Herald" of Dec. 20, which says:

In the bending test more than 64% of the specimens failed to come up to the letter of the contract, and in the quenching test the failures amounted to exactly 50%. In the pulling test 10.7% fell below the contract requirements for tensile strength, and 18% showed deficient elongation.

THE INTERSTATE COMMERCE COMMISSION has presented its tenth annual report to Congress. From advance abstracts issued to the press, it appears that a large part of the report is devoted to a discussion of the effect upon the work of the commission of recent decisions of the United States Courts. The amendments to the law which are recommended by the commission are as follows:

1. To confine the procedure of the courts for enforcement of orders of the commission to the record made before the commission, and to provide that the order of the commission shall be enforced unless the court shall find in the proceeding some material error which furnishes sufficient reason for refusing to enforce it.
2. To so amend section 15 as to make it expressly provide that the commission may, after due procedure and investigation, issue an order requiring the rates, facilities or practices complained of to be changed, modified or corrected as in the order specified.
3. To make railroad corporations liable to indictment for offenses against the statute, as well as their officers, agents and employees.
4. To require the carriers to adopt a uniform freight classification.
5. To make the rate sheets, reports and contracts of carriers on file with the commission, by express provision in the statute, competent testimony and prima facie evidence of what they purport to be in all proceedings before the commission or in the courts.
6. To permit the commission to appoint special agents with the authority to inquire into the business management of carriers.
7. To provide for the interchange of traffic between connecting roads and the continuous carriage of freights from point of shipment to place of destination, as contemplated by sections 3 and 7 of the act.
8. To require carriers to file reports with the commission for each year ending June 30, on or before Sept. 15 next following, and to enforce obedience to this requirement by a cumulative money penalty for non-compliance; to make the provisions authorizing the commission to prescribe a uniform system of railway accounts more specific, and failure to conform to such a uniform system prescribed by the commission a misdemeanor; to require the carriers to file monthly reports with the commission covering earnings and expenses.
9. To require that joint tariffs shall specify the names of the carriers parties thereto, and that each of said carriers, other than the one filing the tariff, shall file with the commission such evidence of concurrence or acceptance as may be required by the commission; to authorize the commission to prescribe and from time to time change the form, contents, and arrangement of the schedules and joint tariffs required to be published and filed.

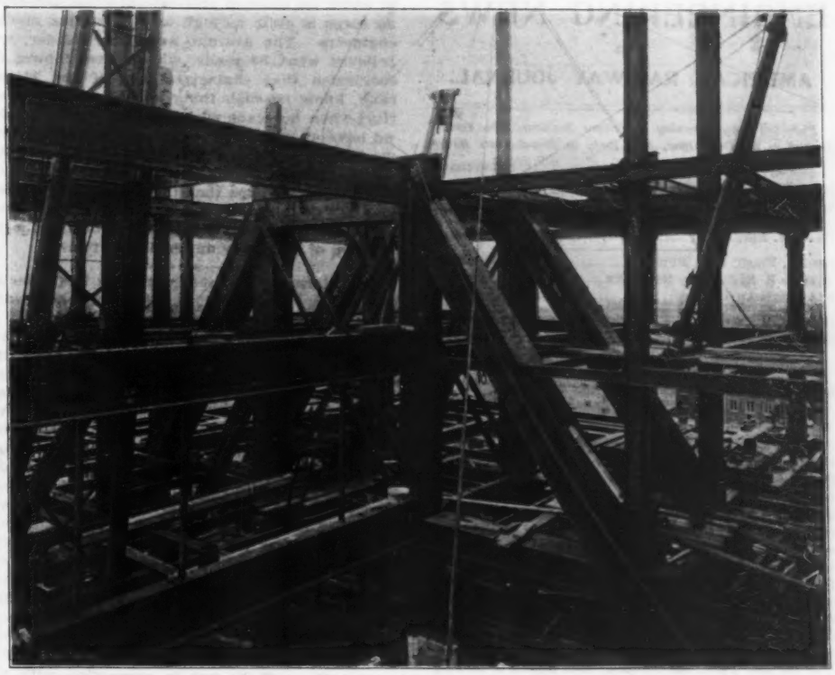


FIG. 14.—VIEW OF BALLROOM TRUSSES.

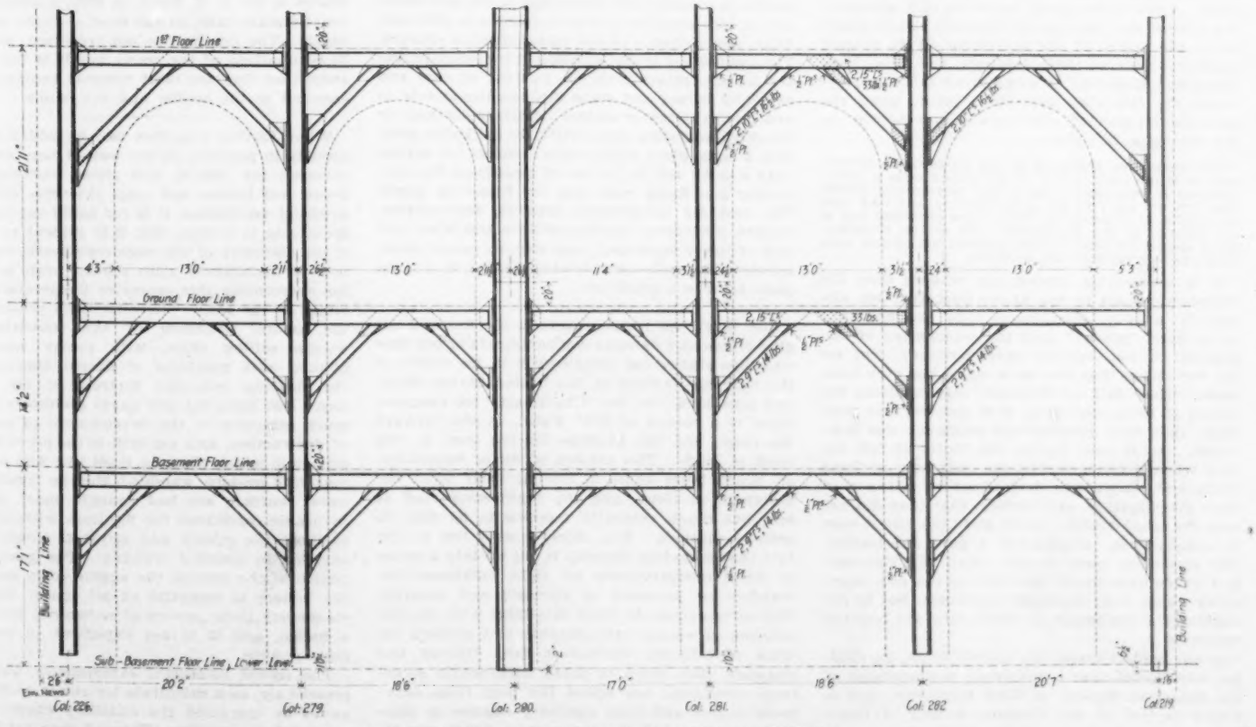



FIG. 18.—KNEE BRACING AND GUSSET PLATE CONNECTIONS.

# ENGINEERING NEWS
AND
## AMERICAN RAILWAY JOURNAL.

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With the reassembling of Congress, the possibility or probability of legislation respecting the Nicaragua Canal is again a theme of public discussion. Most of the journals which are really friendly to the enterprise recognize the fact that the only sensible course for the government to pursue, if it takes any action at all, is to provide for the making of a thorough survey of the route, as was recommended by the commission of engineers last year. A few newspapers, however, still adhere to the absurd idea that the government should guarantee the bonds of the enterprise in its present position. One of these journals, the New York "Mail and Express," in advocating this view, bestows the following gratuitous insult upon the able commission of engineers who reported on the enterprise last year:

> The commission appointed by the President to investigate as to the practicability of the project made a predetermined adverse report, but it was subsequently proved that they did not visit the canal territory, and that their so-called tour of inspection was a mere junketing trip at the expense of the government. All of the objections urged against the canal by this ex-parte commission were shown to be groundless and worthless.

It is needless to inform our readers that the statements made in the above quotation are absolutely without foundation. It has not only never been "proved" that the commission of engineers did not visit the canal territory, but we are not aware that any such claim has ever been made. The "Mail and Express" may condemn the report of these engineers, if it chooses, and may claim that their professional judgment was mistaken; but it goes beyond the limits of fair debate when it charges that the character of these engineers' report was determined in advance of their investigation, and further, that they did not visit the canal territory at all, and their report was, in consequence, necessarily a pure fabrication. The statement made by the "Mail and Express" is a gratuitous insult, not only to the able engineers whom it so wantonly condemns, but to the engineering profession of which they are honored members.

As our readers know, Mr. Alfred Noble, the civilian member of that commission, is a member of the American Society of Civil Engineers, and is Vice-President of the Western Society of Engineers. Major Ludlow and Mr. Endicott are connected with government engineering departments, in which the sense of professional honor and esprit de corps is quite as high as it is among civilian engineers. The average newspaper reader, who believes what he reads, will naturally form the conclusion that engineers, even of the highest rank, know no such thing as professional integrity, when he reads such an item as that which we have quoted above. It is for this reason that we have deemed it worth while to call attention to the matter.

We sincerely hope that the "Mail and Express" may see fit to make such amends as in its power for its unwarranted insult, by publishing a retraction of its wholly unfounded statement.

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The advisability of securing for a large electric lighting or power station a location on a water front, where an abundant supply of water may be had for condensing purposes and where coal may be received and ashes shipped away on boats, has once more been brought to notice by the announcement of an extensive project by the Edison Electric Illuminating Co., of Brooklyn. It has recently purchased a shore front property at 66th St., Brooklyn, measuring 260 ft. on the water front and 1,150 ft. in depth, of which 550 ft. is under water. It is the intention of the company to construct there an electric central station, which will be one of the largest and most economically operated plants of its kind in the world. On the land under water two piers, 60 × 550 ft. each, will be built for handling and storing coal. From the bulkhead line back, a one-story brick building will be erected, which will contain boiler and engine rooms. The engine room will also contain the dynamos and other electric apparatus. The new station will be put in connection with the other stations of the Edison company, and, in addition, will run connections into each sub-district of the city and to surrounding suburban towns as far as Babylon, Roslyn, Garden City and Hempstead. Underground conduits will be used for transmission.

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The economies resulting from the location of a large central plant on tide water, as compared with a number of small plants scattered throughout the city and away from the water, are manifold. Probably the largest saving is that due to the use of condensing, instead of non-condensing, engines, by means of which a saving of from one-fourth to one-third the fuel may be made. Receiving coal by water instead of by rail usually results in considerable advantage to the purchaser, giving him a choice of coal companies to purchase from, and a chance of low transportation charges. The comparison is still stronger if we compare water transportation with the haulage of coal and ashes by horses and carts through the streets to and from the power station, which is common in Brooklyn and other large cities. In the boiler plant also a large plant offers more chances for saving than a small one, in the use of machinery for conveying and firing coal, and for removing ashes. The cost for installation, interest, depreciation, repairs, insurance, superintendence and labor, per unit of power developed, may also, by proper management, be made considerably smaller in a large plant than in a small one.

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The very high temperatures in the fire and engine rooms and dynamo compartments of our new warships stands out prominently in the report of the Surgeon-General of the United States Navy, just presented. On the "Cincinnati," for example, there is a record of 204° Fahr., in the forward fire-room, and the average for the year in this room is 145.8°. The subject of better ventilation on board these ships is forcing itself upon the designers on shore, and the engineering staff at sea; but much evidently remains to be done to remedy matters. The chief trouble lies in the fact that a modern warship is cut up into a series of small compartments by tight bulkheads demanded for purposes of strength and security. This arrangement in itself interferes with the circulation of natural air-currents and renders the work of artificial ventilation very difficult and intricate. But when to these unfavorable structural conditions are added the heat from enormous boilers and from auxiliary engines in close compartments and the steam-pipes which run almost everywhere, the sufferings of the men who have to live and work in these places become well-nigh unbearable.

On the "Detroit" the two passageways on either side of the ship have iron floors directly over the boilers, covering a superficial area of 492 sq. ft. in all. When the ship is under steam the temperature of the floor plates is 135°, and this great radiating surface raises the temperatures of the passageways to 125°. The only escape for this extreme heat is through the end-doors and seven deck ventilators. So far all attempts made to improve upon this condition of affairs have only succeeded in reducing the average temperature to 110°, under the most favorable circumstances.

Of course, much has been done in the way of forced ventilation, nearly all the ships are now provided with Sturtevant blowers, fitted for either exhaust or supply and having a capacity of 10,000 cu. ft. of air per minute. The main ducts from these blowers are sometimes as large as 27 × 15 ins., tapering to 4 to 6-in. terminals, and in addition to these appliances there are in use electrical fans, 12-in. and 14-in. deck and lateral ports, wind-sails, etc. The U. S. S. "Maine" has in each engine room a steam driven blower of 10,000 cu. ft. capacity, with other blowers of varying capacity in the ammunition room, dynamo rooms and steam-steering room; but each of the two fire-rooms depend for ventilation upon three 20-in. cowled pipes leading from above the ship's superstructure and expanded below into large flares.

Aside from questions of personal discomfort, or the dictates of common humanity, the abnormal conditions now surrounding some of the most important working men aboard ship have a serious bearing upon the general efficiency of the ship as a fighting machine. The surgeons, in reporting upon the physical condition of the engineer's force, say that the exhaustion apparent is not due to the work but to the excessive temperature endured while at work; to the motionless impure air in the coal-bunkers, and to the constant clogging of the sweat-glands by the coal dust. The surgeon of the U. S. S. "Detroit" says that in one trip it was only possible to keep the firemen and coal-passers at work by giving to each of these men two ounces of whiskey at the end of each four-hours' watch, and even then the men were almost collapsed, streaming with perspiration, accompanied with stertorous breathing, rapid pulse and trembling limbs. It is a fact worth noting in this connection that in the summary of deaths in the U. S. Navy, in 1895, pneumonia and heart disease rank as the most common causes of death. The deaths are not reported according to occupations of the crew; but it is fair to presume that they are most common among the men engaged in the engine and fire-rooms.

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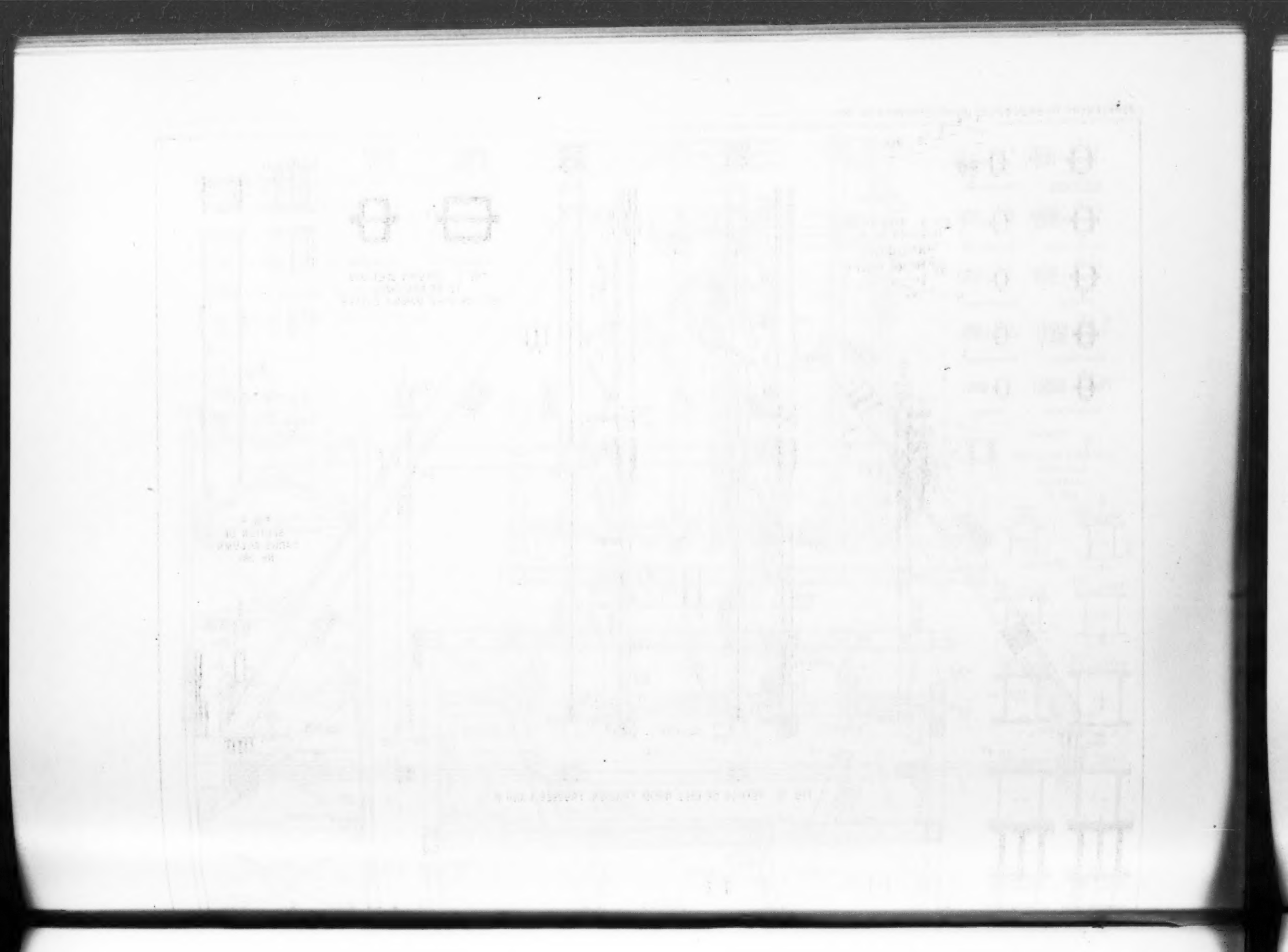
What further remedies can be added to those already in practice, in the way of non-conducting covering for boilers and pipes, non-conducting floors over boilers and more extensive systems of artificial ventilation, it is for naval engineers and architects to decide. But it is evident to all that if the efficiency of the engineer's force, especially, is to be maintained, some scheme must be devised for overcoming this excessive temperature in the vitals of the ship. The difficulties presented are the natural sequence of the transition from wooden sailing ships, with roomy open decks pierced with portholes of liberal dimensions, to the floating iron-clad fortress of the present day. But have not our naval architects paid too much attention to the development of an engine of destruction, and too little to the prevailing conditions in which the men must live who work and man this modern warship? Modern conditions of naval warfare are bad enough under the most favorable conditions for fighting, without adding to these the misery and physical wreck of men engaged in peaceful cruising. The general good health of the men in the engine-room and before the boilers is essential at all times; but in an emergency their powers of endurance may decide a battle, and it is not expedient to overstrain these powers.

The recent successful experiments with compressed air, as a substitute for steam or hydraulic power in operating the auxiliary engines of the coast-defense monitor "Terror," may yet have an important bearing upon this question of better



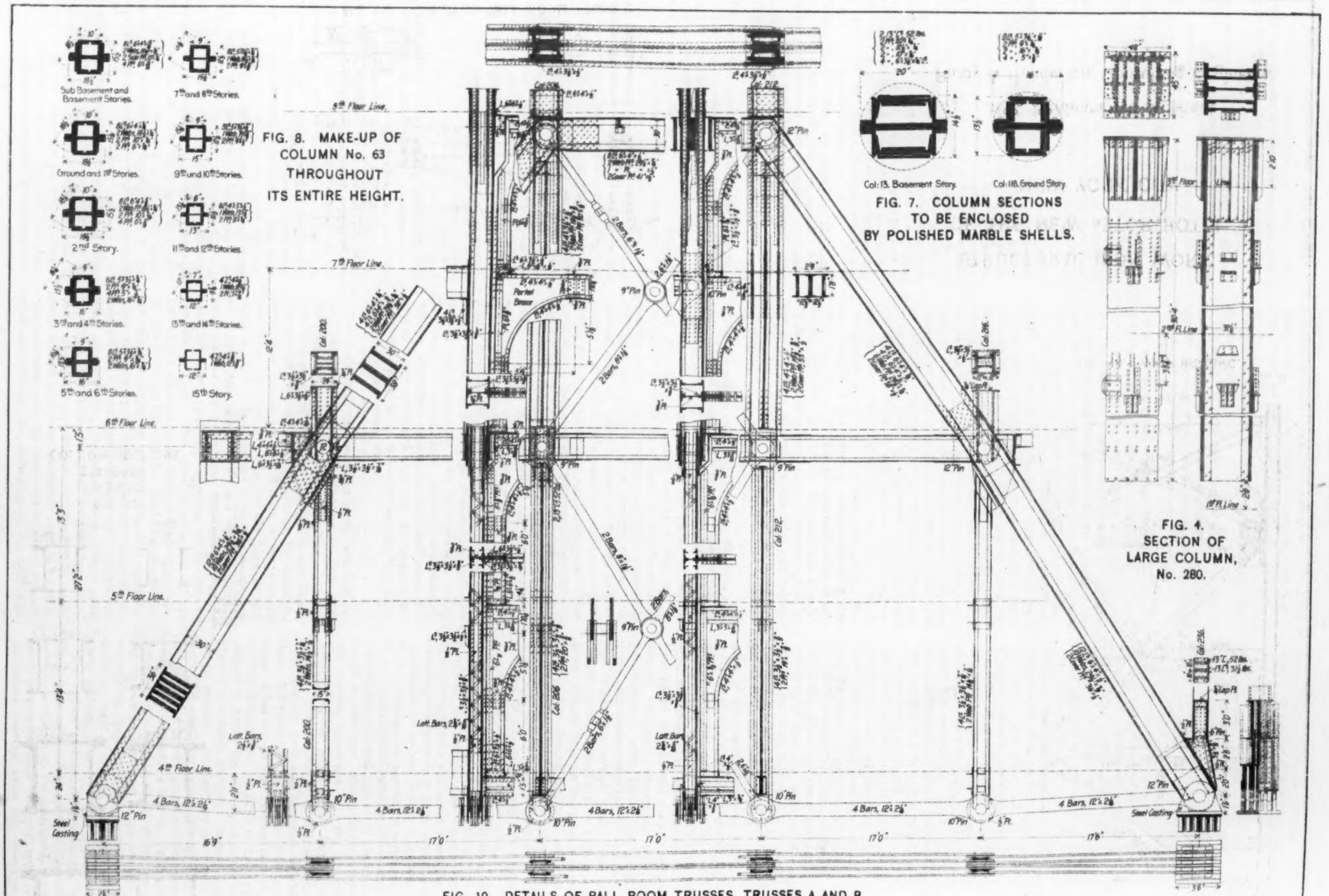
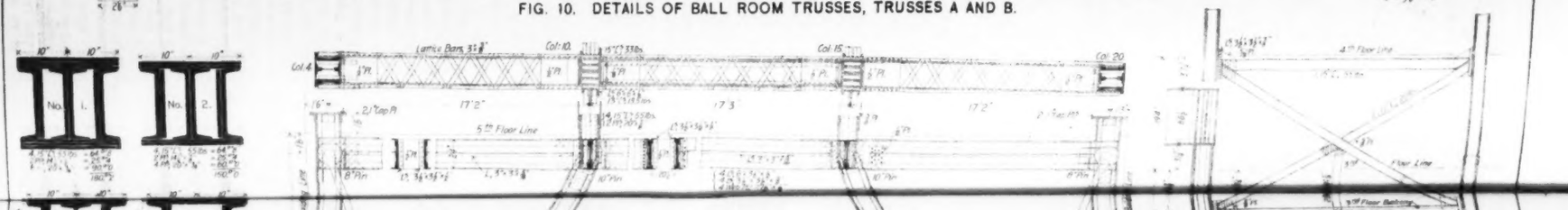



FIG. 8. MAKE-UP OF COLUMN No. 63 THROUGHOUT ITS ENTIRE HEIGHT.

FIG. 7. COLUMN SECTIONS TO BE ENCLOSED BY POLISHED MARBLE SHELLS.

FIG. 4. SECTION OF LARGE COLUMN, No. 280.

FIG. 10. DETAILS OF BALL ROOM TRUSSES, TRUSSES A AND B.



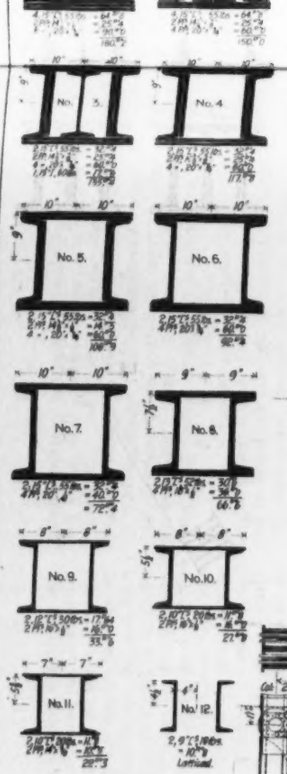



FIG. 6.
TYPES OF
STANDARD
COLUMN SECTIONS

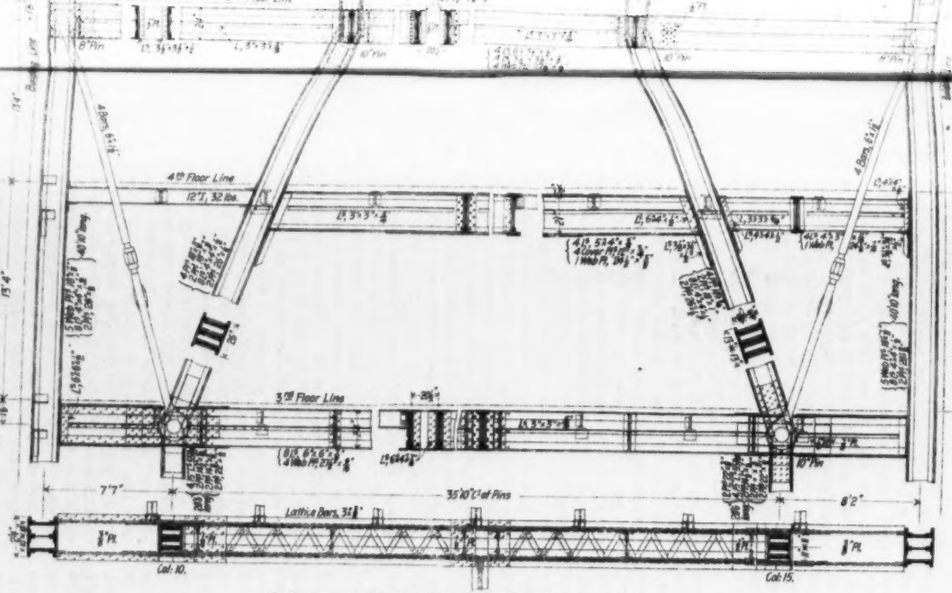



FIG. 16. DETAILS OF DINING ROOM TRUSS D.

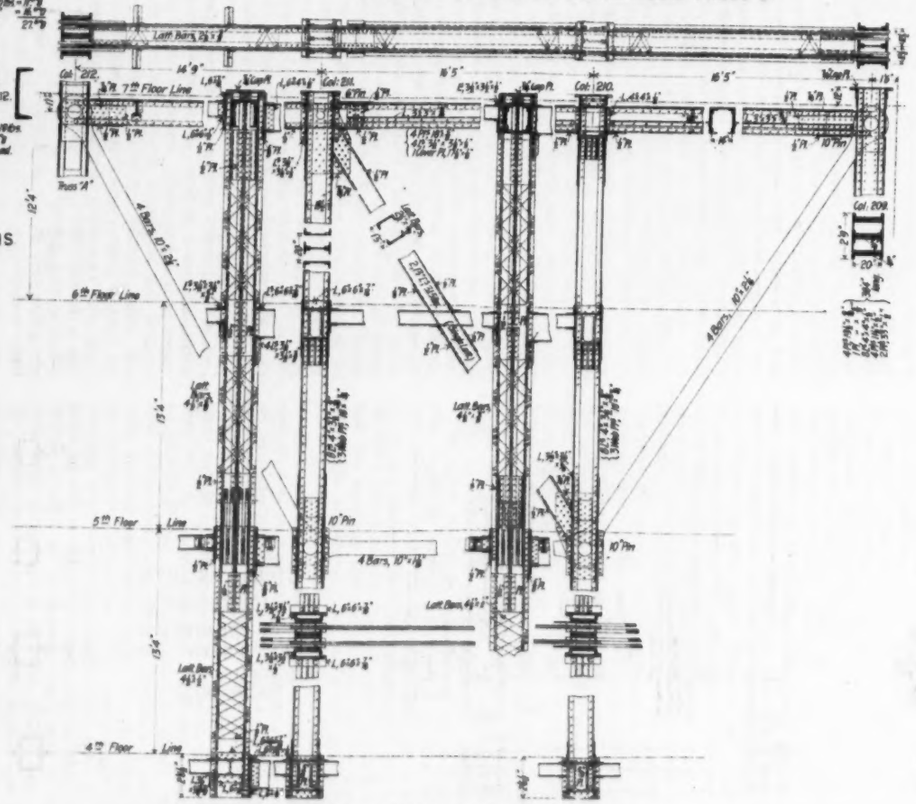



FIG. 15. DETAILS OF BALL ROOM TRUSS C.

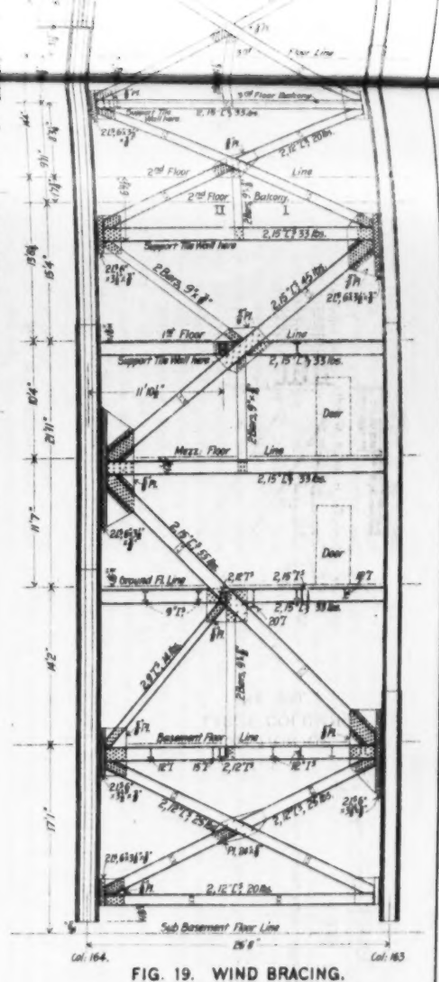



FIG. 19. WIND BRACING.

# STRUCTURAL IRON WORK OF THE NEW ASTOR HOTEL, NEW YORK CITY.

H. J. Hardenbergh, Architect.

Purdy & Henderson, Consulting Engineers.

CHAS. HAST & SONS, LITH., 88 VESEY ST., N. Y.

ventilation. Compressed air is one of the best agents for this purpose, and as it has proved its advantages over steam and hydraulic power in turning the turrets, loading and elevating the guns and steering the ship, its further use as a ventilator of the ship would seem a natural sequence.

The strain upon the physical powers of the workers aboard ship, here referred to, may be better appreciated by noting the number of deaths and prostrations that in any large city follow a heated term of only 100° temperature. Contrast this record, and the conditions of open space and quiet labor with the actual suffering of men who are engaged at the hardest of manual labor in a confined engine or fire-room, with an average temperature of say 150° and a maximum reaching 200°. The only wonder is that they can endure it at all and live to tell the tale; and, in this connection, it may be said that a surgeon's report has nothing to say of the men who part company with the ship after one cruise, physical wrecks, and leave no official record behind them of their later illnesses or deaths.

An extraordinary state of affairs exists in the iron and steel trade. The steel billet pool, which was organized in April last, and raised the price of billets $3 to $5 per ton, remains intact as to its organization, but a single concern (the Bellaire Steel Co.) has withdrawn, and the market is an open one, with cutting of prices the rule. The nail trust collapsed a few weeks ago, and the selling price of nails has dropped 50% as the result. Thus far everything is in the consumer's favor, and to encourage him still further to believe that the era of low prices was at hand, a rumor has been going the rounds of the press to the effect that Mr. Rockefeller, the Standard Oil magnate, who owns some of the largest ore mines in the Lake Superior region, and also the new fleet of steel steam vessels for carrying ore on the lakes, was about to build a great iron and steel works near Chicago, which would compete with the Carnegie works. This report has proved false, and, instead, it is now announced that an arrangement has been concluded between the Carnegie Steel Co. and Mr. Rockefeller by which the steel company acquires control of several properties on the Mesaba range, the ore from which will be carried to Conneaut, on Lake Erie, by the Rockefeller steamers, and thence by Mr. Carnegie's new railway line, the Pittsburg, Bessemer & Lake Erie, to the furnaces and steel works of the Carnegie company at Bessemer, Duquesne and Homestead. The Carnegie Steel Co. some years ago acquired the control of the Frick Coke Co., whose plant was by far the largest in the Connellsville region. Hence it now has in its own control all the raw materials necessary for producing steel, and also all the transportation lines required for assembling them at its works. It has also by far the largest iron and steel manufacturing plant in the world, when its works at different places are taken together, and is reported to be building 16 additional basic open-hearth steel furnaces, which will give it a total of 36 basic furnaces, in which it can utilize the product of mines below the Bessemer grade. The great reduction in the cost of transportation which will follow from the use of steam vessels of great tonnage on the lakes and from the new railway with roadbed and rolling stock especially adapted for carrying ore, together with its unequaled facilities for manufacturing, puts the Carnegie Steel Co. in a position where it will probably be able to produce steel in any shape, from billets to structural material, far cheaper than any other concern in the country, and either to undersell its competitors or to dictate terms to them concerning prices and "allotments." Whether it will use its power to put up or to put down prices is a matter which no one outside of the company may predict.

We congratulate the English engineering journals on the vigor on which they are attacking the schemes of those unscrupulous speculators who are taking advantage of the public interest in motor carriages to sell stock at ridiculous prices in "Horseless Carriage companies." The wholesale manner in which the class of men who a few years ago engineered the boom in worthless South African mining shares are now booming motor carriage companies leads the London "Electrician" to suggest that the most appropriate name for the new vehicle is "Promoter car."

## THE DEVELOPMENT OF STRUCTURAL IRONWORK DESIGN.

The construction of the exceptionally high buildings with steel framework, which now form such a notable feature of the larger American cities, has led not only to the development of a new and large market for structural steel and iron work, but also to new problems in structural design. The introduction of this type of construction dates back only a few years. Previous to that time ironwork design had been limited mainly to bridges, roofs and the framework of factory or mill buildings, none of which cases called for the solution of the problem of superimposed masses of material to form a high, narrow and rigid structure.

We have from time to time published drawings of buildings of this class, with drawings also of the members and the details of construction, and any of our readers who have had occasion to study these critically must have been struck by the many peculiarities in design and the many new governing conditions under which the general and detail designs have had to be prepared. In bridge design the engineer is, as a rule, limited only by the required span and loads to be provided for, and has a free hand to design the structure and arrange the material according to his ideas of what will be most satisfactory. In structural design for tall buildings, however, the engineer is limited by the general plan arbitrarily set for him by the architect. He must so plan his columns and braces as not to interfere with the arrangement of rooms, corridors, etc. This may involve a very unsymmetrical structure, and necessitate the use of heavy beams, girders or even trusses for the floor systems. In a building intended for ordinary office purposes, as are the majority of these tall structures, this general column plan, when once laid out, is carried up through the whole height of the structure, the architectural, or room plan, being practically identical on all the floors. If the structure is intended for other purposes, however, it may be that variations in the room plans will necessitate breaking the continuity of the columns, and this, of course, will very considerably complicate the problem of the structural design of the building. A notable example of this is afforded by the new Astor Hotel, in New York City, which is illustrated on our inset sheet this week. This building will have 15 floors, and on some of the lower floors are a dining room, a ball room and a banqueting room, in which great areas are required to be kept free from columns. The problem was, therefore, to devise some means for carrying the several tiers of floors above these open spaces, and for supporting the columns of these floors, and, at the same time, to provide the necessary rigidity of the structure. In the first two cases this has been done by the construction of great trusses, as described in detail elsewhere, while for the banquet room, where a clear space of 40 ft. between columns was demanded, heavy box girders span this space and support the intermediate columns of the floors above.

Another difficulty which is encountered is in so arranging the floor systems, connections, etc., as to avoid interference with the multiplicity of passages required for flues, plumbing, electric wires, water pipes, etc., and in a large building this is no small matter. Then, again, it is necessary to provide a means of support and attachment for the masonry of the exterior walls, the weight of this masonry being usually carried by a string course of beams or girders at each floor, or at certain intervals. The wind bracing is another special feature in the design, and in many cases diagonal bracing cannot be introduced for this purpose, on account of its interference with corridors, doorways, etc. In such cases a very successful solution of this particular problem has been effected by the use of arched portal bracing, which is, in fact, a modified and improved form of knee bracing, which latter is also sometimes used. In order to ensure absolute rigidity, and freedom from vibration of the floors, horizontal diagonal bracings of flat bars, riveted to the floor beams, is also sometimes employed.

The requirements for wide spacing of the columns may result in very exceptional loads upon certain columns. A column load of 3,000,000 lbs. will be reached in the 30-story Park Row Building illustrated in our issue of October 8, and a load of 5,000,000 lbs. is carried by one column in the Astor Hotel. It will be obvious that very massive construction is necessary to carry such enormous loads; in the latter case we have a mammoth column built up with no less than 10 web plates, 4 cover plates and 12 angles. The weight of this column is 46,980 lbs. in a length of 30 ft. 4 ins.

Another difficulty met with in this hotel building was that the arrangement of trusses and columns could not be harmonized. In one case the truss posts are practically inclined columns, connecting the wider-spaced columns below with the closer-spaced columns above. In another case the outer ends of two great trusses could not be supported by the wall or abutment columns; or by the intermediate columns and it was necessary to provide a line of immense plate girders which spanned the intermediate columns and supported the trusses. While speaking of columns, reference may be made to one special feature calling for special design. Some of the columns in the Astor Hotel, which carry heavy loads, occurred in places where they would not be built into the walls or partitions, but would be isolated, and would be enclosed in shells, or cases, of polished stone. In order to avoid clumsiness in the appearance of the column as thus clothed, it became important to keep the actual metal column as small as possible, and this was effected by the use of column sections specially designed for such locations.

An examination of the drawings of such structural work as we are here considering will show an immense number of cases were specialization in members, details and connections has been required, all of which, of course, add greatly to the trouble of estimating, and the cost of construction, to say nothing of the brain work involved in the solution of the innumerable problems, small and great, but all having an important bearing upon the technical success of the design and the expenditure involved in the building as a whole. These difficulties are probably appreciated not at all by the owner, and only to a limited extent by the architect (unless he is himself an engineer experienced in structural work), and the designing engineer can expect but little credit for the successful results of his labors, since the work is all built in and enclosed as soon as erected, so that the casual observer never gives it a thought, and even if anyone were interested in it, it is hidden from examination.

Few of those who occupy buildings of this class ever realize or think of the enormous amount of metal work involved in the construction. They notice and admire the high facade, the handsome stone pillars, the noble masonry and the expensive and beautiful interior ornamentation; but they see nothing of the great steel skeleton which forms the framework of the whole structure and of which the visible walls and interior finish are but the clothing and decoration. In the Astor Hotel the structural iron work will aggregate about 10,000 tons, as against about 60,000 tons for the completed structure (exclusive of the load), and its cost will be about one-tenth of the cost of the whole building. In the Park Row Building (for office purposes), the structural iron work will aggregate 9,000 tons, or nearly one-seventh of the total weight of the completed building, while its cost will be about one-fifth ($500,000 against $2,500,000) of that of the completed building. The cost of the steel construction is exclusive of elevators, elevator enclosures, stairs, or any work of an ornamental character, while the cost of the building does not include that of the site. In a large warehouse building several stories high, recently erected on Broadway, the cost of the structural work amounts to one-fourth of that of the completed building. This difference in cost is, of course, due to the difference in the character of the "clothing" of the skeleton. In the Astor Hotel a maximum of elegance, profusion and cost will probably be reached, while in the warehouse building (with plain brick and fireproof clothing and little architectural treatment) the proportion of cost will approximate to the minimum. The office building forms a mean between these extremes, having a handsome and expensive finish,

but much less costly decoration than will be found in the magnificent hotel. In ordinary types of buildings it has often been the practice to estimate a cost per cubic foot of the entire structure for different kinds of buildings. While this method has probably little application to such special structures we have been considering, it may be of interest to note that the cost of office buildings of this type figures out at from 20 to 25 cts. per cu. ft.

## LETTERS TO THE EDITOR.

### Wanted, a Test for Tin-Plate.

Sir: There is a well-founded belief that tin-plate is not so good as it used to be, the reason probably being that in modern methods of making it the coating of tin which is put on the iron or steel is carefully brushed off except just enough to make a bare coating without appreciable thickness, while in former times most of the tin which stuck to the iron when it came from the melting pot was allowed to stay on. Tin-plate as now made consists of two things, a sheet of low-priced steel and a coating of high-priced tin. The object of the maker is to sell for so much a pound as much steel and as little tin as possible. The object of the buyer is generally to buy a tin at the market price which will last the longest without having holes rust through it. If he builds a house the architect specifies the best X Y Z's I. C. charcoal tin, but how can he know that the tin he receives is the best or is even of a fairly good quality? Can any of your readers give me a standard of quality of tin-plate for roofing and other purposes, and a method of testing to determine quality? I have a rough idea of a kind of test which might be applied, but before it could be adopted a little chemical research would be needed to establish the details. It is to take a piece of plate, say 2½ ins. square, and by bending the edges ¼-in. wide at right angles, to form a small tray 2 ins. square and ¼-in. deep. Put in this tray a measured quantity of nitric acid of a certain dilution and note the time it takes to eat a hole through the tray. The chemical research needed would be to procure samples of as many different brands and quantities of tin-plate as possible, to expose small samples of each to a number of different corrosive influences, such as salt and water, sea air, distilled water, rain water, dilute acids, etc., and to determine from the results what was the endurance of each under the different circumstances, which samples should be called respectively good, medium and poor, and then to determine just what kind of test could be conveniently applied to any specimen which would infallibly prove whether it should be placed in the good, medium, or poor class. Tester.

New York, Dec. 21, 1896.

### Sewage Filtration at Meriden, Conn.

Sir: In the Engineering News of July 18, 1895, a history of the Meriden sewage disposal ground, from the time investigations for the system were commenced up to that date, was given. Thinking you may like to continue the history up to the present time I send you the following facts: The ten new filtration beds referred to in your article were completed about Dec. 15, 1895, at a cost of $9,483. Since that date the sewage has been confined entirely to the beds, as the filtration system appeared to give better satisfaction to the general public than did the irrigation area.

The sewage is allowed to run on a bed 24 hours at a time, and the beds are thoroughly cleaned before being used again. The inlets to all the beds have been provided with wire screens, which are placed about 20 ft. from the inlet pipe. These screens stop most of the paper and solid matter, and greatly facilitate cleaning the beds.

The solid material removed from the beds is composted and covered with sand, so that we have no trouble from odor.

Up to within the last few months two of the large beds were used at a time; since that date two of the large beds and one of the small ones have usually been used together. The beds were graded level, and with the six inlets at no time has sufficient water accumulated to cover the entire bed, and no water has appeared at the underdrains at any time. As was stated in your article, no underdrains were laid in the new beds. Under the treatment described above, the beds are working as well to-day as they were a year ago, and have not given us the slightest trouble. The following letter accompanied Dr. Herbert E. Smith's report on the beds:

Yale Medical School, New Haven, Conn.,
Nov. 9, 1896.

Mr. E. B. Moss, City Engineer, Meriden, Conn.

My dear Sir: Enclosed I send a statement of the results of my examination of the samples of water. I included in the series the examination of the sample sent me by Mr. Schleiter and taken the day before we took our samples. I found out from him exactly where he took the specimen, and find that it is another of the outbreaks of the effluent from the bed, and it seems to me that it adds strength to the case to include that analysis.

The analysis of Nos. 2 and 3 show conclusively that the purification effected at the beds is remarkably good, the organic matter being reduced to a point very close to that which we find in the best spring waters. That the water coming out at the bottom of the ledge is chiefly the effluent from the beds is seen in a study of the amount of chlorine. The average of the composite samples of the Meriden sewage gives 46.3 parts of chlorine per 1,000,000. Assuming this average as about the amount of chlorine in the sewage, it is easy to calculate that the effluent which contains about 33.5 parts must consist of about three-fourths sewage; of course there is some ground water coming from rain in these springs.

The examination, then, is very satisfactory in showing that the effluent is chiefly composed of the sewage water and that it is highly purified. The results from No. 4, which is the sample taken from the small stream just before it enters the river, seems to show that the bulk of that water comes from the sewage beds after purification. It would be interesting to have that flow measured with a view of ascertaining how much of the purified sewage is accounted for at that point. Comparing the two samples from the Quinnipiac River, it is seen at once that the addition of the purified sewage does not in any way increase the objectionable contamination in the stream, but on the contrary it slightly improves the water, as far as its organic contents goes, adding nothing to it except the mineral matter, which of course is not objectionable.

The samples from the little stream flowing into the Quinnipiac above the filter beds gave only 3.8 parts of chlorine per 1,000,000, showing conclusively that none of the sewage effluent shows in that direction. I think the examination must be accepted as satisfactorily proving that the discharge of the water from the filter beds is not a source of contamination to the river, and that also the beds are working in a very efficient manner. If there are any points concerning the examination which requires further explanation from me I shall be pleased to hear from you. Very truly yours,

Herbert E. Smith.

The effluent referred to in Dr. Smith's report comes out of the ground 21 ft. lower than the grade of the lowest bed. The following will give you some idea of the amount of sewage disposed of: May 23, 1895, 9 a. m., 68,460 gallons per hour; Oct. 31, 1895, Friday, at 2 p. m., 99,276 gallons per hour; July 20, 1896, at 4 p. m., Monday, 70,988 gallons per hour; Oct. 15, 1896, Thursday, at 2 p. m., 81,360 gallons per hour.

It was planned to keep all surface water out of the sewers, but the difference between the amount of sewage in dry and wet weather shows conclusively that a large amount of ground water finds it way into the pipes. Nearly all the factories and large blocks in the city have been connected. Five men and a one-horse dump cart are constantly employed at the disposal area.

Yours truly,

E. B. Moss, City Engineer.

Meriden, Conn., Dec. 7, 1896.

## NOTES OF A TRANSCONTINENTAL TRIP.

### VI.

### San Francisco to Portland; Southern Pacific Ry.

In going from San Francisco to Portland the railway crosses the Siskiyou Mountains. At Chico, 186 miles from San Francisco, the railway is at an elevation of only 193 ft. above sea level. From thence there is an almost continuous up-grade to Siskiyou, where an elevation of 4,130 ft. is attained, 414 miles from San Francisco. From Siskiyou the grade falls to 1,898 ft. at Ashland, Ore., 17 miles further, and continues to fall all the way to Portland, which is only 53 ft. above sea level. The total distance is 772 miles, and the time occupied by the trip is 37 hours 10 minutes. The steepest part of the grade going north is from Red Bluff to Sissons, 113 miles, in which distance the line rises 3,245 ft. The line follows the valley of the Sacramento River on the south side of the range, crossing the river 18 times in 80 miles, and passing through about twelve tunnels through the rocky spurs, while there are numerous loops giving the necessary development to keep within the permissible rate of grade. In one place, near McCloud, the line has a course of five miles to gain an advance of half a mile, but ascending nearly 600 ft. in this distance. All trains stop at Soda Springs to allow passengers to get out and taste the natural soda water which springs up here.

The line presents some very interesting engineering features in crossing the Siskiyou range, and affords some wonderful views of mountain scenery. At Ashland, at the foot of the eastern slope, the last spike of this part of the Southern Pacific Ry. was driven by Mr. Charles Crocker, on Dec. 17, 1887. From here the line follows the Rogue River valley, taking nearly every curve and turn of the river, the railway being for a great part of its length on an embankment right at the side of the river or benched out of the side-hill slopes.

The Oregon division of the Southern Pacific Ry. was completed in 1887, connecting with the Oregon & California Ry. to form a through route to Portland. On the first part of the line the track is fairly good and easy riding, though it is laid with rather light rails and the square suspended joints are spliced by 18-in. angle bars inside the rails and 18-in. fish-plates outside. There are four bolts, 4½ ins., c. to c., with nuts on the outside. Square sawed ties are used, the joint ties being placed quite close together. The ballast is largely of broken stone, shaped to the section usually employed for gravel, and neatly dressed to slope, the toes being lined up with larger stones. In some places, however, the joints are notably defective, and even in the heavy Pullman cars, with their easy springs, the sharp, sudden shocks are felt, which are an indication of particularly bad joints. The superelevation of the track seems to be too high, at least for the speed of the north-bound trains. It is interesting to note the great extent to which the Southern Pacific Ry. is using tie-plates. On the Atlantic system it uses 32 plates to a rail (or on every tie) in renewing rails; while on the Pacific system, with fir ties and broken joints, the plates are used on all joint or shoulder ties. In applying the plates, the ties are turned upside down instead of having seats for the plates adzed out of the worn face of the tie.

All bridges and openings are numbered from the mile posts, as "501 A," etc. Iron guard rails are used on trestles, placed about 8 ins. inside the track rails, and they are extended about 200 ft. on the approaches, being brought to a point at the end. Some of the trestles have the mudsills laid in sheathed trenches, open to the air and to inspection; while some of the large wooden bridges are having the piers and trusses sheathed with planking. There is practically no longitudinal diagonal bracing on the trestles of the Southern Pacific Ry., all reliance for longitudinal rigidity being placed upon the track stringers and the stringers or waling pieces at panel heights. There are several tunnels on this route, most of them having a timber lining. On the Shasta division wood burning engines are used, and it was curious to see the immense balloon smokestacks and the cord wood piled high up on the tenders. Wood fuel is used only on this division and the lines in Oregon. The diamond stack is not used, as all wood burning engines have balloon stacks, and on coal burning divisions the engines have straight cast-iron stacks and extension smoke-boxes. The Oregon Express, a train of nine to ten cars, is hauled over the heavy grades of the Shasta division by two powerful ten-wheel engines built at the shops of the Southern Pacific Ry. at Sacramento, Cal.

A noticeable feature of these locomotives was a peculiar valve gear, which is shown on the accompanying cut, Fig. 1. This is known among the enginemen as the "monkey gear," and was designed by Mr. A. J. Stevens, formerly General Master Mechanic of this road. There are about 60 engines equipped with the gear, but it is not being applied to any other engines. While it was undoubtedly a step in the right direction for fuel saving, the valve is very severe on the running parts of the locomotive, owing to the very rapid admission of steam to the cylinders. The effect of this is to very soon pound out the driving boxes, resulting in heavy maintenance expenses. A report on this valve, by Mr. H. J. Small, Superintendent of Motive Power, is given in the Proceedings of the American Master Mechanics' Association for 1890. It will be seen that there are two separate balanced slide valves to each cylinder, the stem of the rear valve A passing through the hollow stem of the forward valve B. The stems are operated respectively by the valve rods C and D. The valves are driven by a return crank E on the main driving crank-pin. This return crank is set at 90° with the main crank, and from it extends the rod F to the arm G, by which motion is imparted to the link H which has a curved slot in which works the slide-block. The position of this slide-block is regulated from the reach-rod by the vertical arm J, the curved arm K, and the lifting link, L. To the slide-block is attached the radius rod M, the opposite end of which is connected to the vertical lever N. The upper end of this lever has arms to which are attached the valve rods C and D, while the lower end is connected by the rod O to the crosshead P.

The lever is supported by the link Q. The cost of this gear is about 25% greater than that of the ordinary gear, and the cost for maintenance and repairs is also considerably higher, apart from the increase in cost for the general maintenance and repair of the engine. In a comparison of eight ten-wheel engines (cylinders 18 × 30 ins.), fitted with the Stevens gear, and eight ten-wheel engines (18 × 24 ins.), with the ordinary link motion, the former showed a decrease of 18% in fuel consumption and an increase of 41% in cost of repairs. The engines with the Stevens gear made 33.93 miles per ton of coal, as against 27.92 miles by the other engines. At 23 cts. per engine-mile for fuel, the former engines showed a gain of 4.14 cts. per mile; while at 6 cts. per mile for engine repairs the latter showed a gain of 2.46 cts., leaving a final gain of 1.68 cts. per mile run in favor of the Stevens gear.

### Portland, Ore.

This city is one of the largest and busiest of the Pacific northwest, and has a population of about 82,000. It is situated on the west bank of the Willamette River, about 12 miles south of its junction with the great Columbia River, and is 115 miles from the ocean, having good terminals and navigation facilities for river and ocean steamers. The city is about 53 ft. above sea level. It is an important railway center, the Southern Pacific and Northern Pacific railways meet here, and the Union Pacific Ry. has an entrance over the line of the Oregon Railway & Navigation Co. (formerly a part of the U. P. Ry. system) which follows the course of the Columbia River. A railway is now being built to connect Portland with Astoria, at the mouth of the Columbia River, a distance of about 110 miles. The contractors are Honeyman, De Hart & Glenn, and their contract calls for the completion of the road by May, 1897. At the mouth of the Columbia River are the celebrated pile and rock Columbia River jetties (now practically completed), while up the river (above the Willamette) are the Cascade locks (also practically completed) and the site of the Dalles ship railway, which is to give a through route for river navigation. The U. S. Engineer Office, at Portland, is now at work on the drawings for this ship railway or boat railway, and land is being secured for the right of way.

There is a good system of water-works, supplied by an excellent quality of water from Bull Run River. The headworks consist of a canal 400 ft. long, terminating in a funnel-shaped chamber 9 ft. long, which tapers from 60 ins. to 42 ins. in diameter, the latter being that of the discharge pipe. From this chamber extends a riveted steel discharge main, 42, 35 and 33 ins. diameter, 24 miles long, ending in the Mt. Tabor reservoir on the east side of the Willamette River. From this reservoir a 32-in. main leads to the upper of the two City Park reservoirs on the west side of the river, crossing the river by a 28-in. submerged pipe 2,006 ft. long. This was laid in lengths of about 17 ft. by means of a curved apron behind the pipe-laying boat or scow. The Wolff & Zwicker Iron Works (which are briefly described below) made the steel pipe and the Oregon Iron & Steel Co. made the cast-iron pipe. A plan and profile of the pipe line are given in Fig. 2, and the following tabular statement of the bends was taken from a paper on "Flow of Water in Wrought and Cast-Iron Pipes from 28 to 42 ins. Diameter," by Mr. Isaac W. Smith, M. Am. Soc. C. E., which was presented at the San Francisco convention of the American Society of Civil Engineers in June. Mr. Smith is Chief Engineer and General Superintendent of the Water-Works, and Mr. D. D. Clark, M. Am. Soc. C. E., is Principal Assistant Engineer.

| | 28-in. | 32-in. | 33-in. | 35-in. | 42-in. |
|---|---|---|---|---|---|
| Length of pipe, ft.... | 2,006 | 31,073 | 34,345 | 41,034 | 52,915 |
| Total number of bends | 2 | 17 | 85 | 141 | 225 |
| Total degs. curvature. | 21° | 800° | 404° | 782° | 1,913° |
| Ave. curvature pr mile | 6° | 14° | 62° | 101° | 191° |
| Extra joints, per mile for bends ..... | .. | .. | 11 | 29 | 42 |
| Maximum radius, ... | 11 | 11 | 38 | 38 | 38 |
| Minimum radius ..... | 11 | 11 | 14 | 38 | 14 |

The two reservoirs in City Park are not now used for storage, partly on account of the trouble with the creeping of the asphalt lining, and partly on account of some fears for the stability of the ground upon which the reservoirs are built. This matter is now the subject of investigation.* At present, the water from the pipe line flows over a weir and through screens into a vertical cylindrical distributing tank, whence it flows to the gate-house of the lower reservoir. A similar arrangement is provided at the other reservoirs, the water flowing from the distributing tank to the mains. The flow from the upper to the lower reservoir, with a head of 62 ft., drives Pelton water wheels which operate two Fraser & Chalmers pumps of 500,000 and 1,000,000 gallons capacity, these supplying the high-service system at an elevation of 600 to 650 ft. above the reservoir level.

*The reservoirs and the evidences of movement have been described in Engineering News, Jan. 10, 1895, Feb. 7 and 21, 1895, and June 11, 1896.

Monolithic concrete is used for the head gate-house of the upper reservoir, for part of the reservoir wall, etc. It is finished off and pointed to resemble masonry, and gives a very good-looking rock-faced surface. The Mt. Tabor reservoir has a fountain with a 5-in. nozzle discharging a stream of water to a height of 125 ft.

There are several cable and electric railways, and in some cases electric traction has superseded cable traction. The Portland Traction Co. has a cable line with a grade of 21½% on a viaduct of considerable length. The cars on this particular line have track brakes with wooden blocks, a slot-wedge brake, and independent wheel brakes on the front and back trucks. Turntables are used for turning cars at some of the terminals, but they are considered objectionable on account of the cost of repair and the time occupied in turning the cars. Watering cars are run on the electric lines, resembling large double-truck cars, but without windows. The East Side Ry. has some of the Lovejoy convertible summer and winter cars, the sides of which are formed of panels hinged at the eaves line, these panels being folded up against the inside of the roof during the summer. On the cable line of the Portland Traction Co. the yokes are 4 ft. 6 ins. apart, and for rail joints coming between the yokes, a special joint with a support formed by a piece of reversed rail 4 ft. long, has been designed by the general manager, Mr. F. I. Fuller, M. Am. Soc. C. E.

There is no official with the title of City Engineer, but the Superintendent of Streets (Mr. Chase) is practically the city engineer, being in charge of the design and construction of streets, sewers and general municipal work. He is elected by popular vote, as is also the City Surveyor, who is practically a subordinate of the Superintendent of Streets.

On Fourth St. a wood pavement has recently been laid on a 6-in. concrete foundation, with concrete curb. The blocks are 4¼ × 3¾ × 8 ins., made from fir stumps, laid close together on a 1-in. bed of gray sand, and grouted with pitch. There are 8-in. planks laid longitudinally between and outside the rails, upon these being laid cross-planks beveled at the ends to form a flangeway. The track is laid with T-rails, having square joints, spliced with four bolts, the longitudinal timbers being notched or boxed out to allow of access to the nuts. Honeyman, De Hart & Co., of Portland, are the contractors. Some streets are paved with transverse timbers 6 × 6 ins. or 5 × 5 ins., resting on mudsills; such a pavement will last

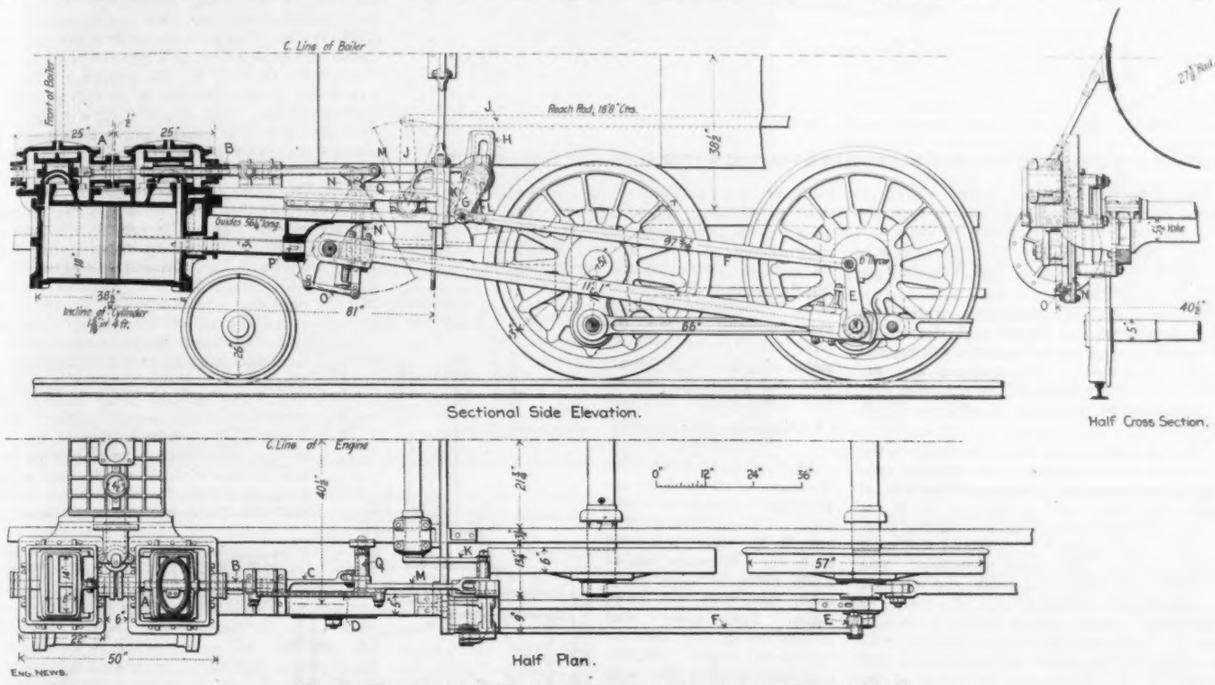



FIG. 1.—STEVENS VALVE GEAR AND DUPLEX VALVES; SOUTHERN PACIFIC RY.

about seven years, and with traffic that will wear it out in that time it is cheaper than brick, asphalt, etc. Square sticks are used, so that they can be laid with the grain edge up, in which position they give much better wear. California bituminous rock has been tried, but it does not give good service, even on concrete or macadam foundation. The material wears in holes, and it is to be stripped off the concrete and Trinidad asphalt laid in its place.

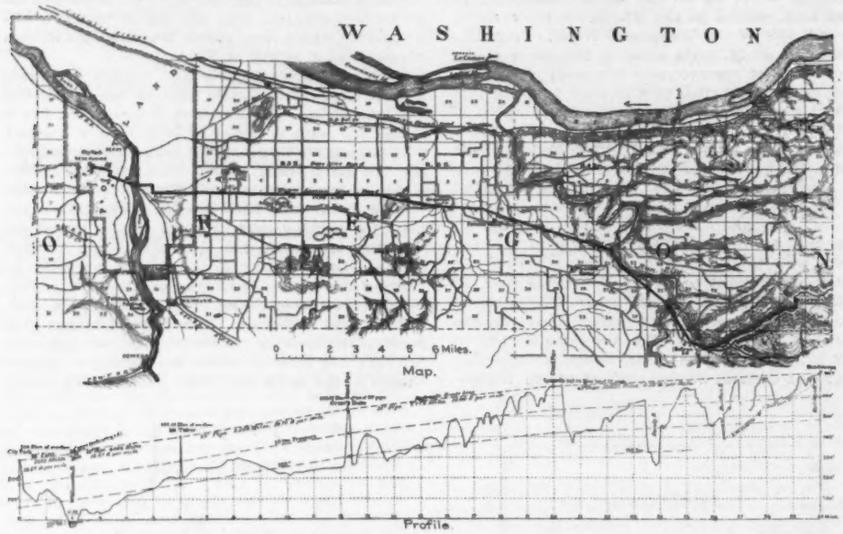



FIG. 2.—PLAN AND PROFILE OF THE BULL RUN PIPE LINE FOR THE WATER SUPPLY OF PORTLAND, ORE.

The city has a garbage crematory, which was built by a local firm. It works well, destroying even carcasses of horses satisfactorily, but repairs are required frequently. This furnace was described in Engineering News of Aug. 20, 1896, and there is talk now of replacing it with an Engle furnace.

About twelve miles south from Portland is the town of Oregon City (reached by an electric railway), at which place the power of the falls of the Willamette River, with a head of 40 ft., is utilized by a water-power plant generating electricity which is transmitted to Portland and used for railway, lighting and power purposes. The power house is to be built in sections, and the part thus far completed is equipped with three pair of Victor turbines, a 42-in. and a 60-in. turbine to each pair for high and low-water service. The vertical shafts of the turbines drive three 600 HP. generators, the armatures of which (7 ft. diameter and 2 ft. high) revolve in a horizontal plane. The oil bearings on the vertical shafts are filled with oil at 175 lbs. pressure. A large amount of machinery is on hand for extensions to the plant, and contracts are to be let for the concrete superstructure of the new part of the building and for new cribwork along the boat canal which passes the falls. This plant is similar to that at Niagara Falls, and antedates the latter, but while at Oregon City the armatures of the generators revolve, at Niagara Falls the fields revolve. The plant was put in by the Portland General Electric Co., of which Mr. Sullivan is the engineer, and was described in Engineering News of Oct. 10, 1895.

Portland has a very fine union station of recent construction, but there is no trainshed, though it is said that one is to be built when times are better. The station was built by the Portland Terminal Co., of which Mr. E. Lyons is Manager.

The Wolff & Zwicker Iron Works, of Portland, have a very complete plant for the manufacture of riveted steel pipe. The special tools for this work include two automatic feed punch machines, capable of handling 60 tons of material per day. From the punches, the plates are lifted and carried by a hydraulic crane to the vertical rollers. After being rolled, the pipe is bolted and rounded up, and the longitudinal seams are riveted by bull riveting machines, of which there are eight, all operated by hydraulic power. The courses are then pressed together with hydraulic presses and carried forward by the trolleys to the round-seam riveting machines. After being riveted they are calked with pneumatic calking tools, and then rolled to dipping tanks to be coated with asphaltum. Their largest contract was the pipe for the Bull Run water supply for the city of Portland, of which there were 24 miles, from 33 to 42 ins. diameter, and made from plate from No. 6 gage to ⅜-in. in thickness. They have, however, manufactured within the past four years, over 65 miles of pipe of all diameters and gages for mining and water-works purposes.

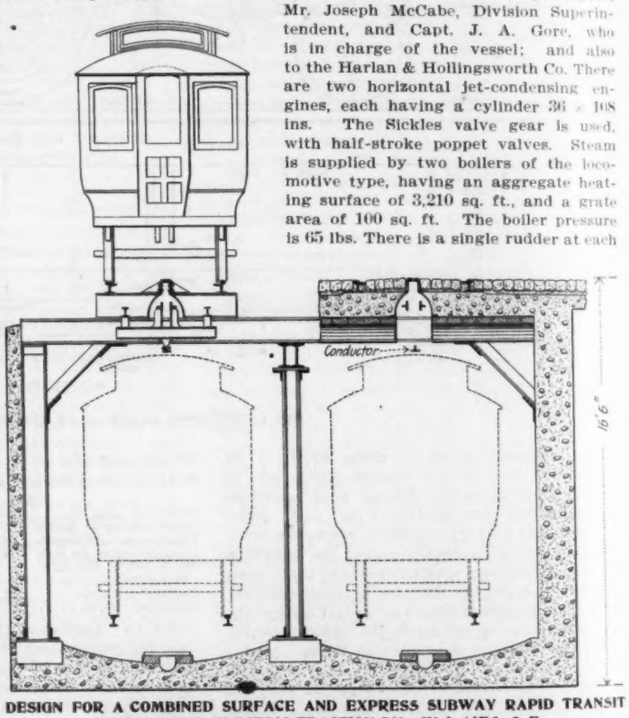
### Portland to Tacoma and Seattle.

At 5 p. m. I went from Portland northward by the through transcontinental train of the Northern Pacific R. R., which is a solid train for the entire run of 2,056 miles between Portland, Ore., and St. Paul, Minn. The train was hauled by a fine Baldwin ten-wheel engine (187,980 lbs., with tender) and was made up as follows: Mail car, baggage car, express car (60,666 lbs. each), colonist sleeping car (63,650 lbs.), two day cars (64,900 lbs.), dining car (90,110 lbs.), and sleeping car (98,310 lbs.), or eight cars in all (weighing 564,168 lbs). In connection with the remarks on dining-car service, in the first part of these "Notes" (Engineering News, Sept. 3) it may be stated that the Northern Pacific R. R. follows the practice of running through dining cars on all its transcontinental trains, an arrangement which conduces largely to the comfort of passengers, ensuring them against the unpleasant delays in getting meals due to trains being late or detained. The sleeping-car service on this line is also worthy of note in that three classes of cars are run. Ordinary sleeping cars are available only for persons holding first-class or "regular" tickets, but this road also runs Pullman "tourist" sleepers for the use of holders of second-class or cheap-rate tickets, these cars being fully as comfortable as and but little plainer than the ordinary sleeping cars, while a uniformed porter looks after the comfort of the passengers. For the use of colonists, etc., the train has, on three days in the week, a free colonist sleeping car, the arrangement of which is similar to that of the other cars, but having a very much plainer finish, with no upholstering or bedding, these materials being supplied by the passengers, who can purchase them at the principal railway stations. A second-class sleeping car is frequently engaged for a tourist or prospecting party, and the car porters find this service more remunerative in the way of "tips" than the more aristocratic first-class car with its more exclusive passengers.

At Kalama the railway reaches the great Columbia River, and here the train is run onto a large steam transfer boat and ferried across the river.

This boat resembles the larger steamer of the Southern Pacific Ry., described in Engineering News, Nov. 5, 1896. The length of the trip is 1.1 miles, and the boat has a speed of twelve miles per hour. The total time occupied, from stop to start of train at the landing stages, is about 30 minutes. The boat was put in service in August, 1884, and has been running regularly ever since without an accident. There are three tracks, united at each end of the boat, to connect with the single track on the landing stage apron, and these tracks can accomodate 27 freight cars (33 ft. long), 15 Pullman cars or 18 ordinary cars. The boat was built by the Harlan & Hollingsworth Co., of Wilmington, Del., in 1883, and Capt. J. A. Gore, who is now in charge, states that it was sent round Cape Horn in sections on the "Tillie Starbuck," being put together by Smith Bros. & Watson, of Portland. It was originally named the "Kalama," but this was changed to the "Tacoma" before the boat was put in service. For the particulars as to this interesting vessel I am indebted to Mr. Charles S. Fee, General Passenger Agent; Mr. Joseph McCabe, Division Superintendent, and Capt. J. A. Gore, who is in charge of the vessel; and also to the Harlan & Hollingsworth Co. There are two horizontal jet-condensing engines, each having a cylinder 36 × 108 ins. The Sickles valve gear is used, with half-stroke poppet valves. Steam is supplied by two boilers of the locomotive type, having an aggregate heating surface of 3,210 sq. ft., and a grate area of 100 sq. ft. The boiler pressure is 65 lbs. There is a single rudder at each end, and the steering gear is operated by hand. The general dimensions are as follows:

| | |
|---|---|
| Length of deck | 340 ft. |
| Length between perpendiculars | 300 " |
| Beam of hull | 42 " |
| Width of deck over guards | 76 " |
| Depth of hull, below deck | 13 ft. 6 ins. |
| Height of superstructure, above deck | 12 ft. |
| Draft, light | 7 " |
| Draft, loaded | 9 " |
| Tonnage, gross | 1,362 gross tons. |
| Engine cylinders | 36 × 108 ins. |
| Boilers, number | 2 |
| Boilers, capacity of each boiler | 300 HP. |
| Heating surface of each boiler | 1,605 sq. ft. |
| Grate area of each boiler | 50 " " |
| Boiler pressure | 65 lbs. |
| Wheels, diameter | 28 ft. |
| Wheels, width | 8 " |




DESIGN FOR A COMBINED SURFACE AND EXPRESS SUBWAY RAPID TRANSIT SYSTEM WITH ELECTRIC TRACTION RY. W. I. AIMS, C. E.

## A PROPOSED PLAN FOR RAPID TRANSIT SERVICE IN CITY STREETS.

We illustrate in the accompanying cut a proposal for a system of rapid transit in city streets which has been submitted to us by Mr. Walton I. Aims, C. E., of 35 Broadway, New York city. It consists of a double-track tunnel just beneath the street surface, and with the track centers directly below the centers of surface tracks in the street above. The plan is to operate express trains upon the tunnel tracks and utilize the surface cars to conduct the local or short distance traffic and to carry passengers to the express stations. Both lines would be operated by electric traction, the surface cars taking current through a slot from conductors which would be readily accessible from the tunnel below. The conduit for the conductors, it will be seen, would open directly into the tunnel and all difficulties with respect to drainage would be obviated. The slot in the conduit, Mr. Aims thinks, would furnish ventilation for the tunnel.

In places where this construction was impracticable on account of local conditions, the subways could be depressed, passing into circular shield tunnels (if in soft ground), and even passing one on top of the other, if necessary, as at some places in the London subways.

Mr. Aims suggests that the construction which he has designed would be a better solution of the rapid transit problem in New York city than the four-track subway which is the plan that has been adopted. In this matter we are unable to agree with him. As a practical question, the city could not annul the franchises of the companies which already operate railways on the surface of the streets, and it is evident that the same corporation should own and operate both the surface and tunnel tracks to make Mr. Aims' plan a success. Again as a purely engineering question, the distances to be overcome by rapid transit lines in New York city are so great and the streets are so crowded that to rely on surface cars to carry passengers to the express stations of a rapid transit system would rob the express service of a large part of its efficiency. But for cities where the distances to be overcome are less than in New York, but still great enough to demand rapid transit, the plan of Mr. Aims seems to be excellently adapted, as it effects the combination of local and express service on parallel tracks, which we believe is the only satisfactory solution of the rapid transit problem in large cities.

## A LARGE DIRECT-DRIVEN CENTRIFUGAL PUMP.

We illustrate herewith a centrifugal sewage pump designed and built for the city of Norfolk, Va., by the Morris Machine Works, Baldwinsville, N. Y. The pump has 20-in. suction and 18-in. discharge, the latter connected to a 20-in. piping. The actual head worked against is 26 ft., but when the pump is driven to its maximum capacity, discharging about 9,000 gallons of water per minute and forcing it through the discharge pipe, which is 1,600 ft. long, the total head pumped against is equivalent to about 5 ft. Inasmuch as this pumping outfit will often be required to run night and day, it was thought advisable in designing the machine to make the pump runner of large diameter so as to keep the engine speed moderately low. The engine, which has 14 and 28-in. cylinders by 18-in. stroke, will, therefore, under average work only run at a speed of from 120 to 140 revolutions per minute and its maximum speed is 180 revolutions per minute. The sewage and drainage from the city flows into a well from which the pump takes its supply, discharging it in the river. The side and sectional views, Fig. 2, show the construction of the pump. The runner is made completely of bronze, so as to withstand the corroding action of sewage and the gases contained therein. The pump shaft is made of steel covered with bronze where it passes through the stuffing box into the pump. In order to keep the sewage from working back into the stuffing box a fresh water injection is arranged which is continually forcing a stream of water through the bearing into the pump, thereby preventing sewage water from working in.

The vanes on the runner are made rather wide apart so as to pass through pieces of wood, rags or other solid matter that may be pumped with the sewage. The high-pressure cylinder on the engine is fitted with a Meyer adjustable cut-off so that the steam consumption can be regulated according to the amount of work the pump is doing.

The engine is throughout very substantially built; the crank shaft is made of steel, counterbalanced; connecting rods are of the forked type, also made of steel; as are also the cross-head, piston rods and valve motion. About a year and a half ago a machine similar in general design to the one here illustrated was furnished for the city of Norfolk, which has, since it was put in, been running almost day and night, giving the best of satisfaction. It can be depended upon, in case the quantity of sewage is small, to work successfully handling a small amount of it, or can be speeded up until without difficulty it takes care of all the sewage which flows into the receiving well. The engine here illustrated is run condensing, exhausting into a jet condenser.

We are indebted to the builders of the pump and engine for the photographs and drawing from which our illustrations are prepared.

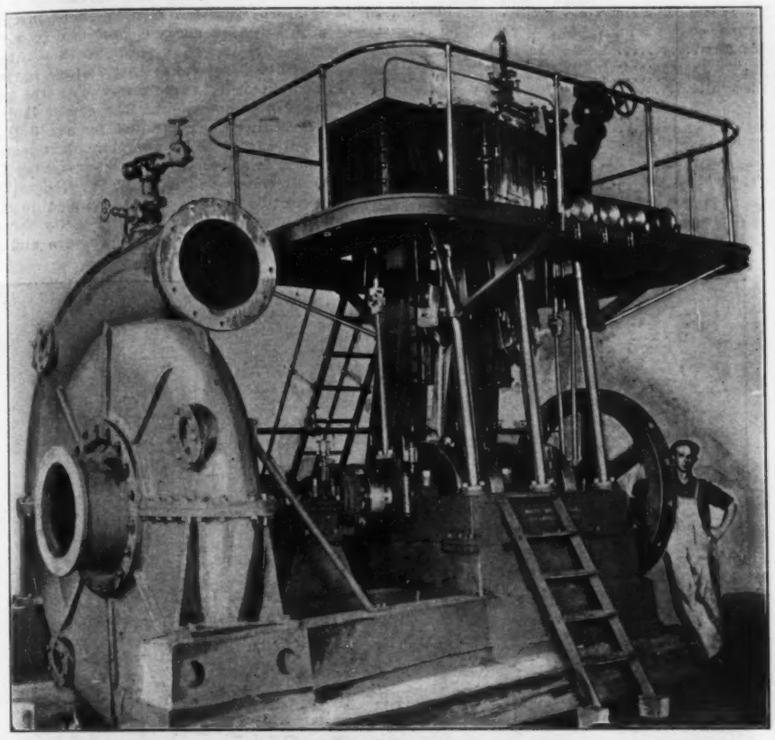


FIG. 1.—CENTRIFUGAL SEWAGE PUMPING ENGINE AT NORFOLK, VA.
Designed and Built by the Morris Machine Works, Baldwinsville, N. Y.

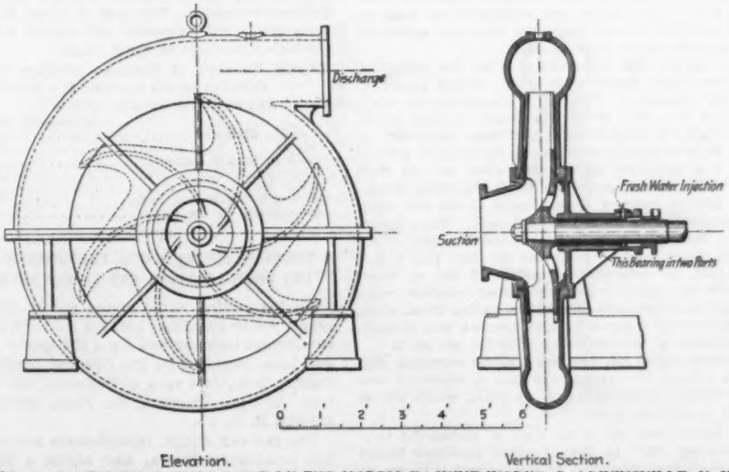



FIG. 2.—CENTRIFUGAL PUMP BUILT BY THE MORRIS MACHINE WORKS, BALDWINSVILLE, N. Y.

## ALUMINUM BRONZE SEAMLESS TUBING.*

By Leonard Waldo, M. Am. Soc. M. E.**

The so-called alloys of copper and aluminum must be considered as radically different from the various metallic mixtures of copper, zinc, tin, nickel, manganese, and lead which have made the bulk of the copper alloys of commerce. There are, as is well enough known, certain chemical compounds among these last-mentioned alloys. In the aluminum bronzes or aluminides of copper there is no commercial method of separating the two constituents.

The results of the chemical [illegible] of aluminum and copper is the strongest of the copper compounds or alloys. Wire is readily drawn from it with a tensile strength of 180,000 lbs. per sq. in.

*Abstract of a paper presented at the New York meeting of the American Society of Mechanical Engineers.
**Secy. Waldo. Foundry Co., Bridgeport, Ct.

But there are points in which aluminum bronze seems mechanically superior to any steel. It cannot, at present, be tempered, but it does not seem to show any change in the nature of crystallization under stress or shock. Thin, soft ribbon may be indefinitely coiled and uncoiled or run over rollers. A bar may be struck indefinitely upon one end. A rifle firing-pin was struck over 120,000 blows without apparently changing its molecular condition. It can be made of all degrees of hardness, and its strength and percentage elongation varied from 40,000 to 100,000 lbs. per sq. in., and from 70% to 1% in 10-in. bars. As an illustration of this combination of strength with ductility, I cite the fact that aluminum-bronze cartridges made for the new small-caliber low-trajectory rifle were fired for more than 90 consecutive rounds, charged with smokeless powder, at the Frankford Arsenal, for a firing test. Added to these mechanical values are the chemical resistance to corrosive influences, and the small electric potential of the combined aluminum and copper. The non-corrosiveness is only excelled by that of the noble metals; and the low, almost zero, electric potential of the aluminum bronze gives it a value in structural engineering which peculiarly fits it for acid industrial works or water-tube boilers and condensers. This value has already been tested on a large scale in underground tide-water retaining bolts in our seacoast batteries and in sulphite pulp mills and the electrolytic vats of large copper refineries. As its cost is reduced by improved methods of working, it is finding its way into many uses where steel or iron has a short life from rust, inability to resist corrosion, or lack of density and strength.

It has long been evident that aluminum bronze was an ideal metal for drawn tubes; but serious difficulties presented themselves at every stage of production, from the ingot down. It was my belief that the Mannesmann or some kindred process presented the most feasible solution of getting the cylindrical ingot in a sufficiently economical way, and after the ingot was obtained that some plant capable of cold-drawing the higher grades of steel was necessary to produce the finished tube. Experiment had shown that aluminum bronze was not to be economically worked, or even worked at all with many grades, on draw benches originally planned for copper or brass. The hardness and high tensile strength combined were found to be destructive to the dies used in the best hydraulic benches for brass and copper. It remained, therefore, for the combination of the casting plant of the Waldo Foundry, under the direction of its superintendent, Mr. E. S. Sperry, to furnish the solid billet; for the newly-introduced Mannesmann plant at the rolling mills of Benedict & Burnham at Waterbury, under the superintendence of Mr. Chas. S. Morse, to convert the solid ingot into a cylindrical tube; and for the new Pope Tube Works, built to cold-draw the nickel and other strong steels, under the superintendence of Mr. H. H. Eames, to convert the cylindrical tube billet of the Mannesmann process into the finished tube for the market. To these three gentlemen is due the success of the process.

The process of making the solid aluminum-bronze ingot has not yet been described. The system of solid hot tubular ingot-rolling known as the Mannesmann process is outlined in some detail at page 384 of the "Transactions, American Institute of Mining Engineers," Vol. XIX., 1891. The Benedict & Burnham Co. have introduced benefiting changes in the details of the process there described, and the Waterbury plant is a model of its kind. From one to two minutes is the time required to reduce a solid three-inch billet to a cylindrical forging ready for the draw bench.

After leaving the Mannesmann rolls the cylindrical aluminum-bronze ingots were given several passes on the draw benches at Benedict & Burnham's, to lessen their size to a point where they could be taken by the Pope company's benches, as at that time completed, the larger Pope company's benches not yet being in place.

The new hydraulic cold-drawing plant of the Pope Tube Works is driven by two triple-expansion, single-acting Riedler pumping engines rated at 500 HP. each, but which can work up to 1,000 HP. each. The arrangement is designed by E. D. Leavitt, and an idea of the total efficiency may be had from the fact that 1 HP. is obtained for somewhat less than 12 lbs. of steam with 135 lbs. initial pressure. These engines work through two hydraulic accumulators having 16-in. rams, and working the 8 and 6-in. draw benches with a maximum pressure at the benches of 1,280 lbs. per sq. in.

Aluminum-bronze tubes require frequent annealing during the process of drawing, and this is especially true of the higher compounds, such as $Cu_4A$, which are as difficult to draw as nickel steel.

It is known that, up to the limit of commercial temperatures—say 400° to 500° F.—that aluminum bronze retains its initial strength. In this respect it shows its great superiority to ordinary brasses and bronzes.

Table I. gives the chemical analysis and the tests of the best brass tubes the market now affords, together with the tests of the same size tubes of open-hearth Swedish steel and a low aluminum-bronze—about $Cu_4Al$, or a 4½% bronze.

TABLE I.—Tests of Tubes at Ordinary Temperatures, Cold-Drawn and Not Annealed.

| | A. Government brass tube. | C. Ordinary brass tube. | S. Swedish open-hearth steel. | P. Aluminum bronze, $Cu_4Al$. |
|---|---|---|---|---|
| Analyses Pope Mfg. Co.'s Laboratory, H. Souther, | % | % | % | % |
| Engr. Tests, Nov., 1896. | [1]59.86 | [1]67.58 | [6]0.420 | [10]95.79 |
| | [2]39.82 | [2]31.67 | [6]0.031 | [10]4.35 |
| | [3]0.35 | [6]0.85 | [7]0.500 | [6]0.05 |
| | [4]0.013 | [6]0.01 | [6]0.031 | ..... |
| | ..... | ..... | [6]0.110 | ..... |
| | ..... | ..... | [8]0.007 | ..... |
| | Ins. | Ins. | Ins. | Ins. |
| Outside diam. | 1.502 | 1.5000 | 1.504 | 1.491 |
| Inside diam. | 1.348 | 1.332 | 1.342 | 1.311 |
| Area in sq. in. | 0.38692 | 0.39584 | 0.3427 | 0.42157 |
| Gage length | 10. | 10. | 10. | 10. |
| | lbs. | lbs. | lbs. | lbs. |
| Yield point. | * | 63,100 | 64,200 | 68,700 |
| Strength per sq. in. | 77,900 | 81,900 | 79,300 | 96,000 |
| Elongation in 10 ins. | 5.4% | 9.3% | 5.4% | 4.9% |

[1]Copper; [2]zinc; [3]lead; [4]tin; [5]carbon; [6]phosphorus; [7]manganese; [8]sulphur; [9]silicon; [10]aluminum; *not defined.

Table II. shows the effect of heating the aluminum-bronze tube of Table I. to a bright red and then plunging it into water. The ultimate strength of 96,000 lbs. per sq. in. and 4.9% elongation becomes changed to about one-half this strength, 47,600 lbs., and to 13 times the per cent. elongation. This ratio of change is at its maximum in the low compounds and reaches a minimum in the high compounds at about $Cu_4Al$.

TABLE II.—Tests of Tubes at Ordinary Temperatures, Cold-Drawn and Annealed at a Red Teat.

Cold-drawn and annealed at a red heat:

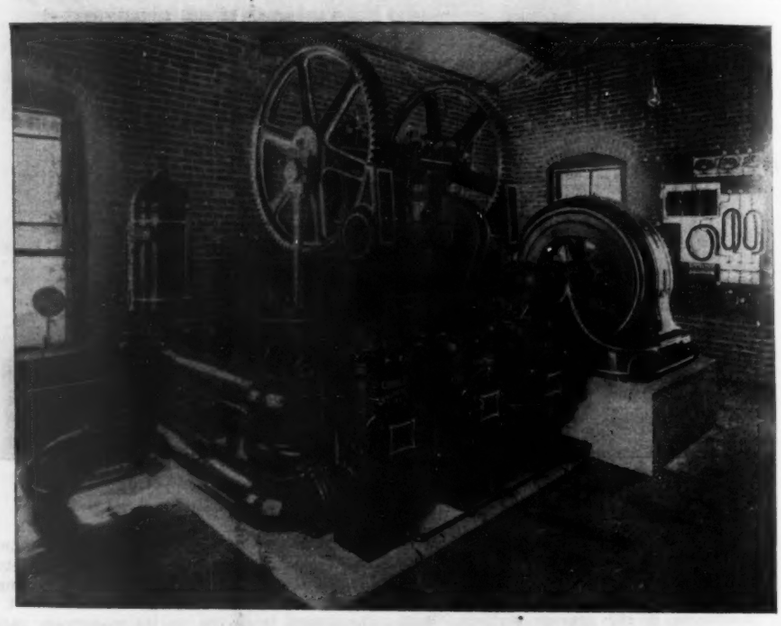
| | Aluminum bronze, $Cu_4Al$. |
|---|---|
| Outside diameter | 1.625 ins. |
| Inside " | 1.415 " |
| Area in square inches | 0.508 sq. in. |
| Gage length | 10 ins. |
| Yield point | 24,200 lbs. |
| Strength per square inch | 47,600 " |
| Elongation in 10 inches | 64.9% |

## A THREE-PHASE ELECTRIC TRANSMISSION SUPPLYING BOTH LIGHTING AND FIRE-PUMP SERVICE.

An interesting three-phase power transmission plant, which furnishes current for both arc and incandescent lighting and for a 750-gallon fire pump, has been installed by the General Electric Co., at Itasca, Wis., just east of Superior, the headquarters of the Chicago, St. Paul, Minneapolis & Omaha R. R. Co.

The railway shops, roundhouses and storerooms are located at Itasca, and about a mile and a quarter distant extensive docks have recently been built, with a warehouse 1,500 feet long and 300 feet wide. Boats are loaded and unloaded on one side of the dock, tracks are laid on the opposite side, and the cars are loaded and unloaded at any point in the warehouse.

The protection of the warehouse from fire, and its lighting by arc and incandescent lights would have required, by the usual method, the installation at the dock of a complete plant of boilers, engines and their accessory apparatus, in addition to the fire pump and electric generator. By the plan adopted, the cost of an engine and boiler plant at the dock, together with the expense of its superintendence and a large part of the operating expenses, have been saved. By this plan the power for driving the pump and furnishing the lights is obtained from the railway shops in the shape of a three-phase current, produced by a General Electric 100 K. W. three-phase generator, at a pressure of 2,000 volts; this voltage having been adopted in order to do away with the necessity of step-up transformers. The engine is driven at 900 revolutions per minute, by a 110 H.P. Ball & Wood engine. The pumping plant installed at the dock is shown in the accompanying illustration. It consists of a 75 K. W. General Electric 2,000-volt induction motor, coupled to a Gould triplex pump of 750 gallons capacity per minute, operating at 80 lbs. water pressure and able to throw four effective fire streams upon the docks and into the warehouse.



AN ELECTRIC PUMPING STATION FOR FIRE PROTECTION AT THE DOCKS OF THE CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA R. R., ITASCA, WIS.

The inside of the warehouse is provided with five fire stations, fitted with electric fire alarm apparatus for transmitting signals between the docks and the engine house; also switches connecting the motor and pump to the power wires. Hydrants and reels are suspended from the walls, each reel having 100 ft. of hose, so that, after the fire signal has been given from the engine house, one man can carry hose and water to the fire in from 10 to 30 seconds. A fire corps has been organized, and the men are drilled three times each week. In addition to current furnished to the pump, the generator also supplies electricity to 12 alternating current arc lamps, 6 on each side of the dock, supported on brackets from the sides of the building. Over 200 16 c. p. lamps are required to light the warehouse; and in Itasca itself about 150 more 16 c. p. incandescent lamps are also installed.

## RAMIE AND CANAIGRE IN MEXICO.

Sir Henry Dering, the English Minister to Mexico, has lately forwarded to the British Foreign Office, an extended report upon the vegetable products of Mexico, and the portion relating to the cultivation of ramie and canaigre is briefly abstracted as follows:

Ramie was introduced into Mexico from Java in 1867, and various companies are now engaged in raising the plant and extracting its fiber. There

are two distinct plants, China grass (Boehmeria nivea) and ramie, or rhea (B. tenacicsima), the stalks of which reach 3 to 5 ft. in height. The best climate for its cultivation seems to be one that has a mean temperature of 36° Fahr. and an altitude of about 800 ft. above the sea. The land must be damp or easily irrigated, rich in humidity and perfectly permeable so that the accumulated dampness may not rot the roots. The fiber produced is fine, silky and brilliant, and superior to all other vegetable fiber in length, strength and beauty. It is used in rope-making and in the manufacture of handkerchiefs, curtains, carpets, tablecloths, etc. Textiles made from it have the strength of linen, and a luster resembling that of silk.

The Mexican Department of Public Works says that from one square league of ground 1,936 tons of ramie can be produced and transported to New York for $203,007; and the price in New York is given as $250 per ton. The capital invested in this particular undertaking was $30,000 for machinery, in addition to the sum named above, or $233,007 in all.

A very interesting part of the report is that referring to canaigre, a tanning material of great value now grown extensively in Mexico, and in certain parts of the United States. This plant is known botanically as Rumex Hymenosepalus and it grows wild in western Texas, Arizona, New Mexico, Mexico and California. It is found generally on sandy loam and in moderately moist localities, and is described as a "many-headed root, black externally and yellow within." Its value lies in the fact that its tubers contain from 23 to 33% of tannic acid, and it has been fully proved to be a most valuable material for making leather. The Mexicans and Indians employ it to some extent as a purgative, and the leaves are used as food, having the general taste and properties of rhubarb, or "pie-plant."

Hemlock bark contains only 14% of tannic acid, and though canaigre has long been used by the Mexicans, both for medicinal and tanning purposes, its use as a substitute for hemlock bark has only recently attracted the attention of the general commercial world, as a valuable source of tannic acid. It is stated that one acre of canaigre, properly cultivated, will yield from 20 to 30 tons of green roots, equal to 7 tons of the dried material ready for shipment. The prices of this product are from $25 to $30 per ton in the United States, and $60 to $80 per ton in Europe. At the lowest estimate of both yield and profits, says the report, one acre of canaigre should bring in $175, and $225 is believed to be a safe and reasonable estimate.

The value of canaigre as a tanning medium is settled, and the only question now is to obtain enough of it at satisfactory prices. Sir Henry believes that an extract containing the tanning properties could be readily manufactured in Mexico, and money thus be saved in transport. The older the root the heavier is the percentage of tannic acid; roots one year old yield 20 to 25%, and older roots yield from 25 to 40%.

THE U. S. BATTLESHIP "TEXAS," says Secretary of the Navy Herbert in an official statement, instead of being in any degree a failure, as has been currently reported, ranks with the best ships of her class in the world. He admits original structural defects in her hull and some of her machinery, but he says these defects have been remedied, except those relating to her water-tight bulkheads, as developed by the recent flooding of the vessel. The Department has issued orders to have these latter deficiencies made good and the work can be done in a few weeks at a comparatively small cost. Mr. Herbert also publishes a letter from Mr. Chas. H. Cramp, treating of the trouble with the "Texas." This letter says that the design submitted by Mr. John, the eminent English naval architect, was the best of all plans submitted at that time to the Navy Department; and though the scantling was light, this lightness was then in accord with the best foreign practice, and the "whole hull construction involved the best mechanical distribution of minimum weight" Mr. Cramp had ever seen. This lightness was a result of the introduction of steel and an undue faith in the effect of this then new material upon the general strength and rigidity of the hull, as compared with iron.

THE BAZIN ROLLER-BOAT is now at Rouen, says the London "Telegraph," with its engines in place and all fittings nearly ready for the trial trip across the English Channel, which it is proposed to make in January next.

WEATHER TABLE FOR NOVEMBER, 1896. (Furnished to Engineering News by the Department of Agriculture.)

| | Stations. | Temperature. (Degrees Fahrenheit.) Average. | Max. | Min. | Range. | Wind. Velocity in miles per hour. Average. | Max. | Direction at time of max. velocity. | Precipitation—rain or melted snow—inches. Total. | Heaviest in 24 hours. | No. of rainy days. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern Cities. | Northfield, Vt. | 37.1 | 69 | −3 | 72 | 10.8 | 42 | SE | 3.55 | 1.53 | 13 |
| | Portland, Me. | 40.4 | 72 | 15 | 57 | 7.3 | 34 | S | 2.45 | 1.02 | 13 |
| | New York City | 48.0 | 70 | 27 | 43 | 14.5 | 52 | SE | 2.12 | 0.89 | 10 |
| | Pittsburg, Pa. | 48.5 | 74 | 19 | 55 | 7.0 | 26 | SW | 2.76 | 0.69 | 11 |
| | Chicago, Ill. | 38.4 | 70 | 6 | 64 | 19.5 | 53 | W | 2.16 | 0.57 | 12 |
| | Omaha, Neb. | 29.9 | 72 | −2 | 74 | 7.5 | 24 | N | 2.02 | 1.59 | 6 |
| | St. Paul, Minn. | 21.8 | 50 | −10 | 60 | 8.1 | 29 | SW | 5.07 | 2.77 | 15 |
| | Duluth, Minn. | 21.0 | 44 | −20 | 64 | 10.7 | 46 | NE | 3.42 | 1.09 | 14 |
| | Bismarck, N. Dak. | 7.2 | 48 | −22 | 70 | 10.4 | 54 | NW | 3.10 | 0.77 | 14 |
| | Average | 32.5 | 63 | 2 | 62 | 10.6 | 40 | | 2.96 | 1.21 | 12 |
| Southern Cities. | Washington, D. C. | 50.6 | 77 | 26 | 51 | 6.7 | 30 | NW | 2.54 | 0.91 | 12 |
| | Louisville, Ky. | 50.4 | 75 | 14 | 61 | 8.2 | 39 | SE | 4.62 | 2.32 | 11 |
| | St. Louis, Mo. | 46.2 | 78 | 13 | 65 | 13.2 | 36 | S | 3.70 | 1.07 | 13 |
| | Savannah, Ga. | 63.4 | 83 | 40 | 43 | 7.4 | 27 | NE | 2.42 | 1.37 | 7 |
| | Kansas City, Mo. | 40.5 | 75 | 4 | 71 | 11.0 | 28 | SW | 1.38 | 1.20 | 5 |
| | Jacksonville, Fla. | 67.4 | 85 | 45 | 40 | 7.1 | 25 | S | 4.55 | 1.32 | 14 |
| | Chattanooga, Tenn. | 54.2 | 76 | 28 | 48 | 6.8 | 30 | W | 5.51 | 2.73 | 13 |
| | New Orleans, La. | 65.2 | 84 | 35 | 49 | 10.5 | 32 | N | 2.82 | 1.62 | 10 |
| | Memphis, Tenn. | 53.2 | 76 | 19 | 57 | 11.5 | 38 | SE | 7.47 | 5.10 | 8 |
| | Palestine, Tex. | 59.2 | 83 | 28 | 55 | 7.9 | 28 | S | 1.67 | 1.01 | 6 |
| | Average | 55.0 | 79 | 25 | 54 | 9.0 | 31 | | 3.67 | 1.86 | 10 |
| Western Cities. | Helena, Mont. | 18.4 | 63 | −22 | 85 | 6.8 | 42 | SW | 3.29 | 1.30 | 12 |
| | Port Angeles, Wash. | *37.0 | *53 | *12 | *41 | 6.1 | *36 | *NE | 7.48 | 1.94 | *16 |
| | San Francisco, Cal. | 53.4 | 66 | 38 | 28 | 7.9 | 31 | W | 4.56 | 2.76 | 8 |
| | Salt Lake City, Utah. | 37.2 | 65 | −2 | 67 | 5.8 | 39 | NW | 3.15 | 1.08 | 11 |
| | Santa Fe, N. Mex. | 39.2 | 64 | 7 | 57 | 6.6 | 33 | SW | 0.25 | 0.10 | 5 |
| | Denver, Colo. | 35.9 | 75 | −9 | 84 | 7.8 | 44 | W | 0.10 | 0.09 | 2 |
| | Yuma, Ariz. | 63.2 | 86 | 42 | 44 | 6.5 | 38 | N | 0.06 | 0.06 | 1 |
| | Average | 40.6 | 67 | 9 | 58 | 6.8 | 38 | | 2.70 | 1.05 | 8 |

* For 24 days.

M. Bazin is as sanguine as ever as to the success of his enterprise, and predicts that ships with rollers 65 ft. in diameter can cross the Atlantic in 96 hours. The experimental boat has three pairs of 32-ft. rollers, with a screw in addition.

AN EXTRAORDINARY FEAT OF DEEP-SEA DIVING is reported from Hong Kong by "Chambers' Journal." In August, 1895, the steamer "Catterthun," on the way from Sydney to Hong Kong, struck upon a submerged rock and was sunk about 3 or 4 miles from Seal Rocks Bay, off the mainland of New South Wales. On board this ship were $45,000 in gold, and the insurance companies determined to make an effort to recover this treasure. Capt. John Hall, of Sydney, was commissioned to perform this service, and by skillful work he located the wreck and found that the bottom of the iron tank chamber containing the gold was 165 ft. below the surface of the sea. The door of the manhole was blown off by dynamite; but the hole was too small to admit a man in a diving dress. But after numerous failures seven boxes of gold were fished up in a kind of basket-net and $39,710 were thus recovered. The wreck was located by trailing a steel cable over the supposed route of the ship, and diver Briggs, with his assistant, descended 9 times to the deck of the ship in one day, remaining as long as 15 minutes on one occasion. Adverse weather, local currents and the extreme general difficulty of the operation consumed the time between May 4 and August 18, of the present year, in the recovery of the treasure after the wreck was located.

A RAILWAY WITH SUBMERGED TRACK, at Brighton, England, called the Brighton & Rottingdean Electric Ry. was opened to traffic on Nov. 28. The peculiarity of this line, 3 miles in length, lies in the fact that the railway is located in the sea parallel to the coast line, and at high tide the road is operated in from 10 to 12 ft. of water. To meet this condition two parallel tracks, of 2 ft. 8½ in. gage each and 18 ft. between outer rails, are laid upon blocks of concrete deeply bedded in the beach and spaced 3 ft. apart. The car, with a capacity for 150 passengers, rests upon a platform supported by four tubular inclined posts, 24 ft. long and well braced at the bottom and top. At the foot of each of these posts is a four-wheeled truck completely boxed in to protect the wheels from obstruction. Down two of the legs pass two shafts, each driven by a 30-HP. electric motor, which takes current from an overhead wire. Down two other posts pass rods operating powerful brakes. The maximum speed attained in the official trial trip was 6 miles per hour. A somewhat similar railway, shorter but running in a much greater depth of water, has been in use for some years past in connecting two villages on the French coast, separated by a narrow tidal stream.

CAR LIGHTING BY ELECTRICITY is in use on the express trains of vestibuled corridor cars now being run by the Southeastern Ry. (England) between London, Hastings and St. Leonards. Each train has five cars, each 50 ft. long, mounted on four-wheel trucks. There are 16 lights in the car, including 1 in the lavatory and 3 in the smoking room. Each car has its own dynamo and accumulators, the dynamo being driven by a 2½ in. link belt from a pulley on one of the axles. The novelty in the system is the means of getting constant voltage independent of the speed at which the train is going. Instead of allowing the speed of the dynamo to vary, and regulating the magnetic field to correct for this, the dynamo is suspended so that its weight gives the necessary tension to the belt. The weight of the machine and the torque on the armature then exactly balance each other at normal output. Any further effort causes the dynamo to be pulled nearer to the driving axle. This slackens the belt and allows it to slip over the dynamo pulley. Thus a condition of equilibrium is reached, and a further increase of speed is impossible. The armature connections are reversed with a reversal of direction of rotation. An automatic switch, worked by a small governor on the shaft, closes first the shunt circuit and then the main circuit as the speed increases to the normal. The inverse operation takes place as the train slows up. The accumulators are placed in two wooden boxes under the middle of the car, one on each side. There are 16 of these to each car, the plates being contained in teak boxes. The dynamos on the car give about 35 amperes at full load. The lamps used throughout are of 10 c. p. at 30 volts, and are controlled from the attendant's recess. A switch turns on one-half or the whole of the lamps as may be required. The equipment was built by J. Stone & Co., to the specifications of Mr. W. Lennard, Telegraph Engineer of the Southeastern Ry.

FOUR MONSTER DYNAMOS are now being placed in the Allegheny County Light Co.'s station at 12th and Elm St., Pittsburg, Pa., by the Westinghouse Electric Co. Each of the dynamos is 30 ft. long and 24 ft. high, and weighs over 110 tons. Each armature is 16 ft. 8 ins. diameter and weighs over 30 tons. Each dynamo is driven by a 2,000-HP. Westinghouse double-acting vertical compound engine. The four machines are designed to furnish current for 20,000 incandescent and 5,000 arc lights.

A ST. LAWRENCE RIVER WATER-POWER PLANT is projected, to be established at Massena, N. Y., and it is said that 100,000 to 200,000 HP. can be developed. A canal will supply the inlet pipes, and the flumes from the turbines will discharge into Grass River, the difference in level between the two rivers being about 45 ft. Stewart & Co., of Wall St., New York, are said to be behind the enterprise; with Mr. John Bogart, M. Am. Soc. C. E., as Consulting Engineer, and Mr. James Patten in charge of the design of the electrical plant.

WATER RIGHTS IN CALIFORNIA are not subject to charges in addition to the amounts paid for the water itself, according to a recent decision of Judge Ross, of the State Supreme Court. The decision was rendered in a suit brought by Mr. Chas. D. Lanning, Receiver of the San Diego Land & Town Co., against one of its consumers. The company sought, it appears, to collect money for the right to use water, as well as for water used. The state constitution provides for the fixing of water rates by County Boards of Supervisors, and the practice which the company sought to follow, and which others have followed, is considered as evading this regulation.

GASOLINE PUMPING PLANTS are said to be under consideration by the Atchison, Topeka & Santa Fe R. R.

as substitutes for the present steam plants at the numerous water stations on the road.

EXAMINATIONS OF ENGINEERS who are applicants for government engineering positions will be held by the Civil Service Commission at Washington, D. C., in January. Those who pass will be placed on the eligible list for the positions of inspector, surveyor, topographer, hydrographer, transitman, leveiman, etc. Particulars may be obtained by addressing "The Civil Service Commission, Washington, D. C."

LOCOMOTIVES FOR JAPAN are now being built by the Rogers Locomotive Works, Paterson, N. J., to general specifications prepared by the authorities of the Japanese Government Railways, the details of the design being prepared by the builders. There are 18 of these engines, all of the mogul type, with eight-wheel tenders. They are for tracks of 3 ft. 6 ins. gage. The leading dimensions are as follows:

| | |
|---|---|
| Driving wheels | 4 ft. 0 ins. |
| Truck wheels | 2 " 4 " |
| Wheelbase, driving | 11 " 6 " |
| " total of engine | 18 " 8 " |
| " total of engine and tender | 40 " 0 " |
| Weight in working order | 92,000 lbs. |
| Cylinders | 16 x 22 ins. |
| Valve gear | Stephenson link. |
| Boiler | Straight top. |
| " diameter | 4 ft. 8 ins. |
| " thickness of barrel plates | 9-16-in. |
| Working steam pressure | 170 lbs. |
| Firebox | Radial-stayed. |
| " length | 8 ft. 6 ins. |
| " width at grate | 2 " 0 " |
| " width at crown sheet | 3 " 9 " |
| " depth at front | 4 " 8 " |
| " depth at back | 4 " 0 " |
| Tubes, 173; diameter | 2 " |
| Tubes, length | 10 ft. 3 " |
| Capacity of tender tank | 2,600 gallons. |

THE LARGEST FREIGHT CARS yet built are said to be two box cars for the Mansur & Tebbetts Implement Co., of St. Louis, Mo., and the Hutchinson Cooperage Co., of Peoria. They are of 40,000 lbs. carrying capacity and weigh about 40,000 lbs. The former has a truck wheelbase of 8 ft. and axle journals 4¼ x 8 ins. The top arch bars are 1¼ x 4 ins.; lower arch bars, 1⅛ x 4 ins.; tie-bars, ½ x 4 ins. The cars were built by the Missouri Car & Foundry Co., of St. Louis, Mo., and their dimensions are given as follows in an article in the "Car Jorunal":

| | M. & T. I. Co. | H. C. Co. |
|---|---|---|
| Length over end sills | 60 ft. 0 ins. | 59 ft. 3 ins. |
| Width over side sills | 8 " 10 " | 9 " 2½ " |
| Height from sill to side plate | 9 " 2 " | 10 " 9¾ " |
| End sills | 7 x 13 " | 7 x 13 " |
| Center sills | 4¾ x 9 " | 5 x 8½ " |
| Side sills | 5¾ x 9 " | 5 x 10 " |
| Intermediate sills | 4¾ x 8 " | 5 x 10 " |
| Transoms | 11 x 5 " | .... |
| Side plates | 4 x 8 " | 4 x 8 " |
| Number of truss rods | 6 | 6 |
| Diameter of truss rods | 1¼ ins. | 1¼ ins. |
| Diam. truss rods at upset ends. | 1⅛ " | 1⅛ " |

RAILWAY EMPLOYEES AS STOCKHOLDERS will be a feature of the Illinois Central R. R. Co., the directors having adopted plans by which its employees can purchase stock. The plan has been prepared by the President, Mr. Stuyvesant Fish, and over 1,500 applications have already been received.

THE ABANDONMENT OF A RAILWAY LINE 30 miles long is recorded in the recent report of the Railroad Commissioners of Connecticut. The Meriden, Waterbury & Connecticut River R. R. was built eight years ago, and was leased to the New York & New England R. R. for the term of ninety-nine years from Sept. 1, 1892, at an annual rental of $22,500, though it had never earned its operating expenses. The rent was only paid till July 1, 1894, and the reorganization committee of the New York & New England R. R. purchased all the outstanding bonds, and delivered them to the New England R. R., which foreclosed the mortgage. The road was sold under order of the Court, and the New England R. R. ceased to operate it, nor has it been operated by the purchaser. Nothing has as yet, however, been done toward taking up the track or removing the bridges or disposing of the station buildings.

## BOOK REVIEWS.

THE STORY OF THE MINE as Illustrated by the Great Comstock Lode of Nevada.—By Charles Howard Shinn. New York: D. Appleton & Co. 8vo.; pp. 272; illustrated. $1.50.

This is not a technical treatise upon mining operations, but an exceedingly readable sketch of the discovery of gold in California, and of the palmy days of silver-mining in Nevada. The author seems to write from the standpoint of intimate personal acquaintance with the pioneers and prospectors of '49; and in any event he has closely studied their character and tells of their personal peculiarities, their trials, suffering and success, or ill fortune, with a delightful freshness. As a history of gold-hunting in California, of bonanzas and of speculation in mining shares, as controlled by the ups and downs of famous mines, it is well worth reading. And the reader of this book will better appreciate the fact that for every dollar in gold or silver thus won there is a counter-balancing amount of human toil, privation, suffering and disappointment somewhere.

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1897.—Tenth Year of Publication. The "Mechanical World," Manchester, Eng. Boards; 4 x 6½ ins.; pp. 202. Price, 6d.

This little book contains a very good collection of useful notes, rules, tables and data, for the use of engineers, draftsmen, mechanics, etc., together with 52 blank pages for a diary, and about 30 pages of advertisements. The notes, rules, tables, etc., appear to be compiled chiefly from D. K. Clark's works and other English authorities.

RETAINING WALLS FOR EARTH, Including the Theory of Earth-pressure as developed from the ellipse of stress, with a short treatise on foundations, illustrated with examples from practice.—By Malverd A. Howe, C. E., Professor of Civil Engineering, Rose Polytechnic Institute, Member of American Society of Civil Engineers. Third edition revised and enlarged. New York: John Wiley & Sons. 12mo.; 132 pp.; illustrated; $1.25.

In this new edition Prof. Howe has added throughout the text a number of examples of retaining walls and foundations as taken from actual practice, and the treatise on foundations is entirely new. The latter, while very concise, covers the general principles of foundations upon rock, earth and soft earth, and the supporting power of piles. Foundations under water and deep foundations are also discussed and illustrated by existing examples. This work has been reviewed by us before and it only remains to say that it is made more valuable still by the revisions and additions.

CATALOGUE OF THE PUBLIC DOCUMENTS OF THE 53D CONGRESS and of all Departments of the Government of the United States for the Period from March 4, 1893, to June 30, 1895.—Prepared under the supervision of the Superintendent of Documents. Washington, Government Printing Office. Large 8vo.; pp. 638.

This is the "Comprehensive Index" provided for by the act approved Jan. 12, 1895, requiring the Superintendent of Documents to issue such an index at the close of each regular session of Congress. As the first issue of a work brought out with a newly organized staff, and in the absence of any previous systematic index of departmental documents, Mr. Crandall has done an excellent work. The arrangement of the Index is entirely alphabetical, covering authors and subjects, and sometimes titles. It is strictly a "dictionary catalogue," without index, side columns, or attempt at complicated chronological or numerical classification. But there are cross references, and with each subject or author is a brief synopsis of the matter dealt with; enough to give an idea of contents and the size and importance of the document. It is in itself an extremely valuable record of government publications, and so far as we have attempted to use it the arrangement is very satisfactory for the purpose intended.

CHEMISTRY FOR ENGINEERS AND MANUFACTURES.—A Practical Text-Book. By Bertram Blount and A. G. Bloxam. With illustrations. Vol. II., Chemistry of Manufacturing Processes. London: Chas. Griffin & Co., Ltd. 1896. 8vo.; pp. 484; $4.50.

We had occasion recently to review Vol. I. of this work, which treats of the chemistry of engineering, building and metallurgy, and expressed our opinion that it was too much condensed to be of great service to engineers engaged in any particular specialty. The same criticism might be made of this second volume, but the authors forestall it by the following paragraphs in their preface:

> The sole object of the chapters comprising this volume is to give the reader a general view of the principles which underlie the several manufactures described. It is in no way intended to present such an account of details as will suffice for the student of any particular industry, as indeed must be obvious from the size of the book.
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> The usefulness with which the authors venture to accredit their work is to be found in the fact that it seeks to expound those dominant principles which are too often hidden beneath masses of mere detail, and are consequently apt to be overlooked by the specialist in any one branch, to his detriment, in that he frequently fails to apply to his own work principles which are matters of common knowledge elsewhere.
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> These remarks are rendered necessary by the fact that the scope and intention of the first volume of this book appear to have been occasionally misunderstood.

With this explanation before us we are disposed to be rather lenient with this second volume. It treats briefly of the chemistry of the manufacture of sulphuric acid, alkali, artificial manure, lime and cement, glass, sugar and starch, oils, resins and varnishes, soap and candles, coloring matters, paper and pasteboard, pigments and paints, leather, glue and size, and minor chemical manufactures, also of destructive distillation, petroleum, clay industries, brewing and distilling, textiles and bleaching, and is probably as good a handy manual on this variety of subjects for the use of a general reader as can be expected in a work of its size. A bibliography at the end of the work is useful in giving sources of information for those who desire further details on any particular subject.

A TEXT-BOOK OF PLANE SURVEYING.—By William G. Raymond, C. E., M. Am. Soc. C. E., Professor of Geodesy, Road Engineering and Topographical Drawing, in the Rensselaer Polytechnic Institute, New York, Cincinnati, and Chicago: American Book Co. 8vo.; pp. 484; with illustrations and diagrams; $3.

In this work Prof. Raymond has set forth, in an exceedingly clear and simple manner, the whole art of plane surveying. It is especially designed as a text-book for beginners, leaving to the teacher the work of amplification rather than that of explanation of the subject. With the exception of two formulas only, a knowledge of trigonometry is all that is required by the reader or student. The work commences with a very complete illustrated description of the instruments and appliances used, with directions for their adjustment and care, practical hints as to their handling, and the various degrees of accuracy attainable under different conditions of use. This matter takes up the first 140 pages and includes an excellent special chapter on stadia measurements. Land survey computations follow, with a full treatment of the computation of areas by the modern method of co-ordinates; and in this connection there is an illustrated description of the use of planimeters of various types, and an unusually full treatment of the slide-rule, as designed by Gunter, Mannheim, Thacher and Fuller, with clear directions for their use. Book II. applies to general surveying methods, presenting and discussing common problems of land surveying, for both private and public lands and for city work. The laying out of curves is briefly described, in principle and practice, and then follow topographical surveying, simple triangulation and map-making, including the use of the plane-table, etc. Chapter X. takes up earthwork computations, by ordinary methods and by estimation from maps. Under the head of hydrographic surveying are described the methods and location of soundings, the use of the sextant, and the measurement of velocities and discharge. Underground surveying, for mines, etc., and the instruments and methods employed, complete the more technical portion of the work. In an appendix are included a large number of problems and examples, and articles on the judicial functions of surveyors, the ownership of surveys, and the geographical positions of base lines and principal meridians governing the public surveys. A full series of tables applicable to land surveying finish the volume, including those of the common logorithms of numbers and the logorithms of trigonometric functions. This work is to be especially commended for the fullness and clearness of its text, its excellent illustrations, and its modern treatment of the problems of plane surveying.

AMERICAN HIGHWAYS.—A popular account of their conditions and of the means by which they may be bettered. By N. S. Shaler, Dean of the Lawrence Scientific School of Harvard University. New York: The Century Co. 12mo.; cloth; 293 pp.; illustrated; $1.50.

Prof. Shaler, as a member of the Massachusetts Highway Commission, engaged in the actual work of laying out and building country roads in that state, and as a geologist and a close student of roadway practice here and in Europe, is well fitted to write upon this subject. Commencing with a general history of roadmaking, from the Romans to Telford and Macadam, this work takes up the early American roads, and the effect of climate and influence of topography and forests upon roads. The nature and distribution of road materials and their method of use are very fully discussed by this competent authority; and as these materials cover about all that is available in almost every section of the United States the hints given as to their best use and the methods for testing their suitability for roadmaking purposes, are exceedingly valuable. The difficult problem of road maintenance, by the government, by states and by private corporations, is next taken up, with an expressed preference for state administration, somewhat after the manner adopted for Massachusetts and here described. The preliminary study for and the construction and repair of roads forms another long chapter, teeming with practical suggestions and advice deduced from modern practice. Supplementary to this is another chapter on road administration and inspection, the Commonwealth system being here again advocated. Following this are chapters on road machines, cost of road-building and the importance of specific training and education in highway engineering. In his summary and conclusions Prof. Shaler says that the failure of the Americans to attain success in the management of their highways is not due to any lack of public spirit or to any incapacity to deal with public affairs, but is mainly to be ascribed to the exceeding popular ignorance as to the nature and value of good roads. Consequently the first important step towards the amendment of our system is the education of the people as to the means whereby roads may be improved. His book is one of the best means towards this end; for while it is written for popular use, it is the work of one who knows whereof he speaks, and it is quite as useful, in its practical hints and directions, to the engineer as it undoubtedly is to those who wish to be better informed as to the material value of good roads as compared with bad ones.

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